Maintenance of Local Authority Roads

England	Scotland	Wales	Maintain:	Remarks:
County Councils	County Councils	County Councils	*In England and Wales:* all county highways in urban areas for which the borough or district council has not become the highway authority (see below); all highways in rural areas except those the maintenance of which they have delegated (see below). *In Scotland:* all highways except unclassified highways in small burghs and any others maintenance of which has been delegated.	
County borough councils	Large burgh councils	County borough councils	All highways.	
Claiming non-county borough and urban district councils	Does not apply in Scotland	*Claiming* non-county borough and urban district councils	All highways except county bridges.	Non-county borough and urban district councils with a population over 20,000 may *claim* the right to maintain all county roads in their area and thus become the highway authority for them. The county council reimburses the cost of this work.
Delegated non-county borough and urban district councils	*Delegated* small burghs	*Delegated* non-county boroughs and urban district councils	All non-county roads in their area and those county roads the maintenance of which is delegated to them.	County councils may delegate some or all of their highway functions on county roads to non-county boroughs and urban district councils (in Scotland to small burghs), who then act as the county's agents. The county council reimburses the delegated authority for the whole cost of maintaining such roads.
Other non-county borough and urban district councils	Small burghs	Non-county borough and urban district councils	All non-county roads in their area.	
Delegated rural district councils		*Delegated* rural district councils	If delegated by the county council, all roads in their area.	County councils may delegate some or all of their highway functions on county roads to rural district councils. Delegation to rural district councils is however relatively uncommon.

Chapter 1: The Scope of the Report

Introduction

1. We have found our task worthwhile but difficult; worthwhile because, as the following pages show, we have been able to make so many firm recommendations for improvement; difficult because of the nature of the subject. Maintenance is not easy to separate from other aspects of highway work, it embraces a variety of ill-defined operations and it suffers from a lack of basic data. The inherent complexity of the subject would in any case make the creation of a logical and orderly structure difficult even if highway maintenance were managed centrally by a single organisation. In fact, there are over 1,000 local highway maintenance authorities in Great Britain.

2. The great scope for improvement constitutes a challenge which we believe will be readily taken up. Happily, in the course of our investigation we met with every encouragement from local authorities and their officers who spared no effort to help us. We were able to view our subject both in its departmental setting and in the context of the local authorities' total activities. Most encouraging of all was the general recognition that much needed to be done and that new ideas should be given a fair trial. It was gratifying to find that having such a potential for creating disturbance we have, nonetheless, been made welcome and given so much co-operation.

3. Our difficulty has been to live up to the expectations aroused by our activities. We have tried to do this by concerning ourselves both with the immediate practical possibilities and with the more distant scene. Some of our studies were complete in themselves and have led to recommendations for immediate action; others were preliminaries to further research and development. Though some of our recommendations may be humdrum, others are dependent upon the development of sophisticated techniques at present in their infancy.

4. We explain broadly in the following two chapters how highway maintenance is financed, organised, manned, administered and executed. These two chapters set out the background of our study and the evidence for the need to change. Using the breadth of experience in the Committee itself and the material extracted or developed in the course of our studies we have considered in the remaining chapters how much could be accomplished in both the short and the long term. Our conclusions and recommendations are contained in the individual chapters. The summary of recommendations in Chapter 16, where they are grouped both by subject and according to the bodies to which they are

addressed, lists only the more important of our proposals. The scope of our conclusions is briefly indicated below.

Standards

5. A first step towards greater efficiency would be the acceptance of common standards for the many operations of highway maintenance. We have therefore drawn up for general application a set of proposed maintenance standards, presented in Appendix 1 of our report. They are the essential starting point for the development of adequate planning measures, the effective management of manpower and the operation of financial controls. They should be adopted at once as targets and will no doubt be gradually refined in the light of experience and as new techniques are introduced. The ultimate goal is the creation of objective standards.

Selecting Priorities

6. In addition to defined standards authorities need a system of selecting priorities between maintenance projects. We demonstrate how both engineering and economic priorities may be identified, by a maintenance rating system based on the standards and by economic assessments of alternatives respectively. Proper allocation of resources will not be achieved until these approaches are generally adopted. Appendix 2 presents the rating system, Appendix 3 the method of economic assessment.

Training

7. Important though work study is in securing labour productivity it needs to be accompanied by training for the job, both technical and administrative, at all levels. In this field highway maintenance has a long way to go. The gains in efficiency from greater attention to training may well be as great or greater than can be obtained in any other way and we make firm proposals to this end.

Organisation and Techniques

8. We make recommendations about the planning and organisation of maintenance work and contracting arrangements. We illustrate the uses of such techniques as discounted cash flow and have ourselves made use of operational research facilities.

Control

9. Too many authorities exercise control over the flow of expenditure but do not relate it to output. We have therefore presented in some detail a method of controlling the labour, materials and plant concerned in maintenance, designed to secure at the same time effective financial management. We set out a variety of methods of developing improved productivity by means of work measurement and by using work study figures as a tool of management. Other proposals cover methods of plant costing, replacement policies and financial reporting with suggested forms for use at different levels.

Statistics and Data

10. Existing data for studying and controlling highway maintenance at both national and local levels are sadly deficient. But standard data on maintenance from all authorities are needed as the basis for proper expenditure decisions. Given the necessary lead it should not be difficult to institute some clear and straightforward methods leading to standard accounting and data for maintenance. Only if the end products are common to all authorities will there be any advance in the analysis and collection of data from different parts of the country. Our recommendations are intended, if only in their bid to remedy the lack of uniformity, to lift the subject over the hump which at present makes comparative study difficult and has hampered us in our investigations.

Economics

11. We have considered whether the country's present expenditure on the various classes of road is too much or too little and offer some tentative answers. We also considered in some detail the allocation of the sums available for maintenance between classes of road and different maintenance functions within individual authorities. The proposed initial standards will involve some increase in expenditure but many of our other recommendations should lead to savings. However the savings will not be achieved at once and will probably not be sufficient to compensate for enforced economies in the past. We therefore believe that expenditure on the maintenance of major roads needs to be increased.

Chapter 2: Need for our Study and How We Obtained Our Information

Present Position: Factual Background

What is Maintenance?

1. The term maintenance is interpreted differently in rural and urban authorities and according to particular authorities' internal organisation. There is also no clear dividing line between small improvements and maintenance. For the purposes of our report we have taken maintenance to mean those activities designed to preserve rather than to improve the highway. However the way in which authorities recorded expenditure prior to 1967 has generally not permitted us to extract expenditure on minor improvements from the data we have analysed. It is also important to note that local highway authorities' own funds have generally to finance not only maintenance in our sense but also the provision of new items such as traffic signs and pedestrian crossings. The following list suggests the range of activities covered by our studies:—

STRUCTURE

Resurfacing and corrections to camber
Reconstruction and strengthening of foundations
Surface dressing
Patching
Gully emptying and repairs to drainage
Kerb and footway maintenance
Maintenance of bridges
Maintenance of embankments
Siding and verge maintenance.

AIDS TO MOVEMENT AND SAFETY

Snow and ice clearance
Repair and maintenance of: carriageway markings
signs
traffic lights
pedestrian crossings and street furniture
road lighting.

AMENITY

Grass cutting
Hedge trimming and maintenance of trees and shrubs
Sweeping and cleansing.

Classification of Roads

2. Though the road classification system was not devised for the purpose of highway maintenance it is relevant to our report. The classes of road and nomenclatures were altered in 1967 as shown below:

Before April 1967	*After April 1967*
Trunk roads	Trunk roads
Class I roads	Principal roads
Class II roads	Other classified roads
Class III roads	Unclassified roads
Unclassified roads.	

We refer to the old classes in most of our report because so much of our data were available only in a form relating to the classes before the change. Our recommendations are generally related to the new classification but it was necessary to modify this in some cases as explained in Chapter 4. In the Table facing page 6 we also use the term *county roads*; county roads are defined in the Highways Act, 1959, Section 21.

Who Carries Out Highway Maintenance?

3. Highway maintenance is complex not only in its variety of activities but also in the manner of its administration and execution. Trunk roads, including trunk road motorways, in England are the responsibility of the Minister of Transport; those in Scotland and Wales are the responsibility of the respective Secretaries of State. However none of their government departments has a direct labour organisation and the actual maintenance work on trunk roads is therefore carried out by the appropriate local highway authority, designated in this case as the *agent authority*. Agent authorities for trunk roads are generally county councils though in England and Wales some county boroughs and other urban authorities, and in Scotland some large burghs, also have this role. The division of administrative and financial responsibility for the maintenance of non-trunk roads between local highway authorities of which there are over 1,000 in Great Britain is shown in the following Table.

Present Position: Why Need it Change?

4. It is commonly assumed that the wide variations in maintenance standards and expenditure are due entirely to differences in terrain, climate, traffic density and so on. This is not so. Human and organisational influences and wealth in terms of the product of a penny rate also play their part.

5. The paucity of financial and statistical information and its lack of comparability and consistency have so far prevented either central or local government from making a thorough study of the subject. Though most authorities record expenditure on maintenance under several different operational heads, some do not. Often too much expenditure (over 60% in some cases) is left unexplained under a *miscellaneous and general maintenance* heading. The Ministry of Transport's returns for all-purpose trunk roads contain different

headings from those for motorways. Nor does the Ministry insist upon agent authorities observing the headings provided. At least one authority places more than 50% of expenditure on trunk road maintenance under the general maintenance head. There is therefore a complete lack of consistency.

6. Nevertheless decisions have to be made from year to year about maintenance expenditure and standards. There is considerable evidence that their quality suffers from a lack of information. Many local authorities report that standards are a matter of "the engineer's judgment". As a result budget allocations finally depend on the interplay of these judgments and the views of council members. Differences and discrepancies between local authorities in their treatment of similar kinds of roads are therefore to be expected. Even allowing for these difficulties the variations are remarkable.

7. The following figures, based on data collected by the Road Research Laboratory (RRL) from a sample of 22 authorities, illustrate the position. They are calculated as authorities' annual averages over 5 years and cannot therefore be dismissed as reflecting exceptional conditions occurring over short periods:—

a. The proportion of trunk road maintenance expenditure devoted to resurfacing varies:
—from under 20% to over 60% in rural areas
—from under 10% to over 55% in urban areas.

b. Average annual resurfacing expenditure on Class I roads varies:—
—from £170 to £1,670 per mile in rural areas
—from £80 to £2,680 per mile in urban areas.
Ranges in cost per 1,000 vehicle miles are:—
—from 7d. to 340d. in rural areas
—from 5d. to 185d. in urban areas.

c. The proportions of Class I road maintenance expenditure devoted to surface dressing and resurfacing vary greatly, as in the following examples:—

	Surface Dressing	*Resurfacing*	*Other*
Counties	2·4%	68·2%	29·4%
	12·4%	32·3%	55·3%
Urbans	1·3%	67·3%	31·4%
	12·6%	6·8%	80·6%

d. The proportion of Class I road maintenance funds devoted to lighting ranges in rural authorities from 0·2% to over 6% and in urban authorities from 8% to 30%.

e. On Class II roads annual maintenance expenditure varies:—
—from £470 to £1,870 per mile in rural areas
—from £910 to £3,200 per mile in urban areas.
Ranges in cost per 1,000 vehicle miles are:—
—from 130d. to 915d. in rural areas
—from 90d. to 710d. in urban areas.

These figures strongly suggest misapplication of resources. We tried, by analysis of the available data, to measure and explain the inconsistencies in terms of variable factors such as weather and terrain. Our failure to explain more than

about half the variation (see Chapter 11) has confirmed the large part played by subjective judgments in producing the present differences between authorities.

8. Further reasons for these discrepancies suggested by our other studies include differences not only in policy but in method, organisation and overall efficiency. There are efficient authorities organised to take advantage of all that is best in modern management techniques on the basis of a well directed programme; in these many of our recommendations have long been common practice. There are however others where less imaginative management has led to maintenance being carried out with out-of-date equipment in the hands of workmen who have gravitated into the work late in life and received little training. In these there is no plan. Difficulties are not anticipated, and there may even be a practice of waiting for the next complaint. It is against such a background that our report should be read.

Need to Establish the Facts

9. There is considerable disagreement on the status of maintenance. On the one hand it is alleged to be a Cinderella among activities, under-mechanised, making little use of research and deprived of funds so that resources may be devoted to purposes with a more immediate public appeal such as education or housing or even road improvements. There is a strong body of professional opinion which holds that many of our roads, particularly those subject to heavy traffic, are maintained to such low standards through lack of funds that they will fail unless more money is spent. On the other hand Britain is said to have the best maintained local roads in Europe especially in rural areas. Statements that expenditure on maintenance has been rising steadily year by year are countered by references to the alleged inefficiency of maintenance organisation. Clearly the need to establish what is now and what should be the status of highway maintenance was an additional reason for our appointment.

Sources of Information for Our Study

10. We had five main sources of information:—

a. Internal documents and experience available in the Ministry of Transport;
b. Published reports;
c. Reports from abroad;
d. The studies we commissioned and our own researches;
e. Evidence submitted to us.

(a) Information Available in the Ministry

11. The Ministry provided background information on most aspects of our work including trunk road maintenance administration and finance. We have also relied heavily on the RRL for whose helpful co-operation we are most grateful. They undertook a substantial specific study, made available research papers and kept in close touch with our deliberations.

12. Although ours is the first detailed examination of highway maintenance in this country, there was a study by the Working Party on Productivity in Maintenance and Minor Improvements set up in March 1965 with members from the Ministry of Transport and county councils. Their aim was to devise a means of measuring productivity changes over a period with the object of assessing improvements over the previous 10 years and of identifying factors accounting for the variations between authorities. They concluded that detailed analysis of individual activities was needed before proposals for improving productivity could be formulated. This supports the approach we have adopted. The Working Party suspended their activities when our Committee was set up.

(*b*) *Information Available from Published Reports*

13. We have taken account of several recent reports. For example on staffing matters such as training and the employment of technicians we referred to the work of the Mallaby Committee[1] whose report, with that of the Royal Commission on Local Government in England[2], also contributed to our consideration of the most suitable size for a maintenance authority. Our consideration of productivity was materially helped by Report No. 29 of the National Board for Prices and Incomes (NBPI)[3] which emphasised the great scope for improvement in the productivity of local authorities' labour forces given better management training, better supervision on site and wider use of work study. On selective tendering we noted the views of the Lofthouse Working Party [4], the Banwell Committee[5] and the twin Working Parties subsequently set up by the Economic Development Committees for Building[6] and Civil Engineering[7].

(*c*) *Foreign Reports*

14. Our work has benefited by developments abroad where similar problems have been encountered. Publications of the USA Highway Research Board, brought to our notice by the Ministry of Transport, have been useful eg their work on measurable work units as the basis for a management system, work study, unit costs and non-financial budgeting. We also learned about both American and Canadian experience from the Highway Research Board's 1968 Maintenance Management Workshop attended by an RRL officer closely concerned with the studies the Laboratory did for us.

15. In addition we were fortunate enough to hear about recent developments in maintenance in New Zealand. We are grateful to the New Zealand Ministry of Works for information about their uniform standards of maintenance for state roads and their training and work study programmes.

(*d*) *The studies we commissioned and our own research*

16. Most of our conclusions are based on the commissioned studies described briefly below:—

(i) A detailed investigation of existing maintenance standards and expenditure by the Road Research Laboratory for whom this represented the first step

in a projected long-term study of the subject. 22 local authorities co-operated in this study; each prepared a detailed maintenance expenditure and policy report which the Laboratory followed up with visits for further discussions and observations. This study enabled us to examine expenditure patterns both on individual maintenance functions and on different classes of road. We were then able to consider what further data were required to decide how appropriate these patterns were. Our recommended provisional maintenance standards are based upon the data obtained and codified in the RRL study.

(ii) We engaged PA Management Consultants Ltd to devise a simple means of measuring the productivity of local authorities' direct labour maintenance forces and to make recommendations for improving productivity. Use of the method they proposed will enable highway authorities to calculate the productivity of their maintenance force and to convince themselves of the scope for improvement. The data for the study, in part already available to the consultants, were up-dated and confirmed by visits to 15 additional local authorities. The RRL's investigations also provided information on productivity at site level.

(iii) PA Management Consultants Ltd were also commissioned to study the administration and financial control of highway maintenance. They sought to devise a rational form of organisation and recommended improvements in management control. The study involved visits to 33 local authorities as well as to Ministry of Transport headquarters and divisional offices.

(iv) We commissioned the Local Government Operational Research Unit (LGORU) to carry out a small-scale exercise, designed to determine the relative value of roads from a limited number of factors, so that maintenance resources could be concentrated on the roads of greatest value to the community.

(v) A three-month study by the University of Warwick aimed at assessing in economic terms the cost of delays to traffic caused by statutory undertakers' works. Our discussion of the effect of statutory undertakers' work on maintenance covers the results of this report.

17. Our conclusions on some subjects are based more directly on our own work. On training, we did not commission a specific study but relied both on the considerable experience of some of our members and on detailed discussions with local authority officials and senior officers of the following organisations:—

a. The Institute of Works and Highways Superintendents;
b. The Local Government Training Board;
c. The Construction Industry Training Board;
d. The City and Guilds of London Institute;
e. The Four South-West Counties Training Scheme.

18. We studied possible control systems. In particular we compared the control system pioneered in Cambridge, which places greater emphasis on physical than financial controls, with the system based on financial units recommended to us by the consultants.

19. We also did work on sufficiency ratings, a method devised in the United States to evaluate a road's adequacy and to compare in numerical terms the conditions of a number of roads. Our discussions were greatly helped by the fact that one of our members had made a study of sufficiency ratings during a visit to the USA. We looked at some of the sufficiency rating systems used there, particularly those of Iowa and Colorado, and also at proposals for a British system prepared by the County Surveyors of Lincolnshire (Lindsey) and Leicestershire. For our conclusions about the value of a rating system for maintenance we are indebted to work carried out for us by the County Surveyors of Lanarkshire and Lincolnshire (Lindsey) and the RRL.

(e) Evidence Submitted to the Committee

20. The press release sent out on the day of our first meeting indicated our readiness to consider any evidence put to us, and later we specifically invited a number of professional and trade organisations to present their views. We are grateful to those who responded, many of whom made most interesting suggestions which we were able to take into account in our studies. The names of the individuals and organisations which submitted evidence are listed in Appendix 11.

Chapter 3: Size of Maintenance Problem

Methods of Financing

Trunk Roads

1. The Exchequer pays for the maintenance of trunk roads which include most motorways. The departments—the Ministry of Transport, the Scottish Development Department and the Welsh Office—decide the level of expenditure and reimburse the agent authorities.

Other Roads

2. There is little central control of the amount spent on the maintenance of non-trunk roads. The funds for their maintenance come from the rates and the rate support grant paid by central government to local authorities as a means of subsidising the latters' finances and first introduced in April 1967. The total to be distributed to local authorities as a whole by way of rate support grant is calculated from assessments of total local authority requirements for their various activities including highway maintenance. Allocation of the grant to individual local authorities is however based on a formula which takes into account population, resources, numbers of pupils and students, road mileage and other objective factors. What each authority receives is not therefore directly related to its estimated expenditure on particular services.

3. An essential feature of the rate support grant is that once the funds are allocated each local authority is free to spend them as it chooses. We accept that the autonomy for detailed allocation of the resources accorded to local authorities by the rate support grant system is sound in principle. The corollary is that the government must accept that the grant cannot be used to influence individual authorities in their method of carrying out maintenance, or in determining their priorities or scale of investment. From our particular point of view the present distribution formula means that the maintenance needs of individual authorities are not reflected in their share of the rate support grant.

4. Since the rate support grant is a fairly recent innovation and highway maintenance is only about 3% of local authority total expenditure, we do not wish to suggest that any change should be made to the system at present. We believe however that when maintenance needs can be objectively assessed, this information should be used to influence both the total amount of the rate support grant pool and its distribution to individual local authorities. The bids made by individual authorities for highway maintenance would then be based on defined criteria and central government should take this into account when considering the total amount for the pool. We RECOMMEND that when the

distribution formula for the rate support grant is next reviewed, the government should bear in mind that sufficient data may be available to enable them to include in the formula a weighting factor which would more adequately reflect authorities' maintenance needs.

Levels of Maintenance Expenditure

5. In 1968/69 over £160m was spent on highway maintenance in Great Britain exclusive of lighting and administration. Of this, about £18m was central government expenditure on trunk roads; the remainder was spent on local authority roads. The level of maintenance expenditure has risen considerably over the last ten years but it is not possible to assess the rate of increase precisely because, prior to 1967, maintenance was not accounted for separately from minor highway improvements. Highway maintenance expenditure alone is however now running at twice the combined figure for 1957. The following Table, based on the latest available expenditure figures from a sample of 33 authorities, shows how maintenance expenditure relates to total local authority spending:—

Proportion of Funds Spent on Highway Maintenance in 1967/68 by 33 Authorities

Type of Authority	Annual Expenditure			Maintenance as a percentage of:	
	Gross (all purposes) £ million	Highways Total £ million	Highways Maintenance £ million	Gross Expenditure	Highways Total
Counties	431·4	58·3	15·08	3%	26%
County Boroughs	208·1	17·3	4·78	2%	28%
Boroughs & UDC's	25·7	3·1	1·35	5%	44%
	665·2	78·7	21·21	3%	27%

Restriction of Maintenance Funds

6. In January 1968 the government asked local authorities to reduce their planned highway expenditure by 15% in 1968/69 and 1969/70. In December 1968, in agreeing the total level of highways expenditure for the rate support grant pool for 1969/70 and 1970/71, Ministers assumed that maintenance expenditure on minor roads would continue to be restricted. Clearly the need to obtain the maximum value for each pound spent becomes ever more crucial. Financial stringency has highlighted the need to secure the best value from the available funds in terms of preserving the value of the country's investment in its highway system.

Factors Affecting Maintenance Expenditure

Increased Traffic

7. Maintenance expenditure has apparently risen greatly over the past ten years. However the increase has to be considered in conjunction with inflation, the vast increase in traffic, especially heavy goods traffic, and the growth in road mileage over the same period. The number of vehicles in use has risen by over 80%. Vehicle mileage is expected to rise by a further 50% between 1969 and 1980. The number of heavy goods vehicles has risen by over 20% and their permitted size and weight have also increased; permitted axle weights have increased from 9 to 10 tons and the largest standard vehicle now weighs 32 tons instead of 24 tons as in 1959. The ton-mileage travelled by heavy goods vehicles each year has also risen considerably, from 25,000 million to 43,000 million. Older road structures were not designed to carry such volumes of heavy traffic. Serious deterioration is becoming evident with a consequent need for costly and extensive strengthening and reconstruction works. These are a charge against maintenance funds.

Increased Road Mileage

8. Expenditure on new construction, widening, re-alignment and other improvements has increased vastly in recent years, now exceeds £300m per annum and still grows. This level of investment will not however suffice even to hold the situation at present levels of congestion during most of the 1970s. The urban situation in particular can be expected to worsen. The high growth rate in the use of vehicles is widening the imbalance between the demand for and the supply of highway space. Existing roads will inevitably face an increased strain and require correspondingly greater maintenance.

9. In addition, the mileage of roads to be maintained has increased over the same period from about 190,000 to about 204,000, which includes some 500 miles of new motorway, which need to be maintained to a high standard. The amount of cyclic maintenance required on many miles of trunk and principal road has also greatly increased by widenings and improvements from single to dual carriageway.

Higher Standards and New Requirements

10. Not only have costs and wear on our roads increased but the last ten years have also seen other demands made on maintenance funds. For example the standard of such functions as salting, snow clearing and street and sign lighting has been rising rapidly. There has also been a growing emphasis on traffic management, coupled with Ministry of Transport recommendations on aids to movement and safety. Highway authorities are consequently obliged to spend more, both absolutely and proportionately, on such features as traffic signals, road markings and signs. One-way systems for example make additional calls on maintenance funds because they often divert heavy traffic to lengths of road which it did not previously use. One London borough has found that new regulations brought an increase of 60% in its number of illuminated traffic signs

between April 1965 and December 1968 at an estimated additional annual cost of £3,600. This authority has had to double expenditure on road markings in the same period.

11. Central government policy can also directly affect the adequacy of funds available for maintenance. The abrogation of the non-feasance legislation by the Highways (Miscellaneous Provisions) Act 1961 has obliged authorities to carry out more inspections of roads and footways and this too, with insurance against claims from the public, now takes its share of the available maintenance funds.

Conclusion

12. The size of the highway maintenance task is increasing at a faster rate than the funds currently available. In this situation it is imperative to increase the efficiency with which work is done. The problem is acute and involves all aspects of the management of highway maintenance. The remainder of our report is concerned with ways in which highway authorities might in due course achieve better value for money.

Chapter 4: Standards

The Need for Maintenance Standards

1. Defined standards in engineering terms, establishing when and how roads of different types should be maintained, do not exist in any collected, published form but are urgently needed. Without readily available recognised standards there will be but limited progress towards more effective planning, management and productivity; nor will it be possible properly to evaluate or allocate maintenance expenditure.

2. Ideally standards would indicate what needs to be done, and when, to keep the road as closely as possible to the required state with the least expenditure of resources over the life of the road. They would be the result of ascertaining in quantitative terms the physical condition necessary for each length of road to provide defined and acceptable conditions of safety, amenity, reduction in wear and tear on vehicles, comfort, driver strain and so on. Such standards would presuppose that there are means of measuring objectively both the structural state of roads and the benefits to the community. At present the necessary means do not exist on the scale required: only a beginning has been made in measuring by mechanical techniques on a large scale the physical conditions, for example skidding resistance, while methods of estimating benefits to the community hardly exist as yet.

3. Highway maintenance is thus in much the same position as other public services for which meaningful measures of output—physical, economic and social—have still to be found. We applaud the efforts now being made to solve this problem and indeed have found of great value the preliminary work done by the Ministry's Highway Economics Unit, the RRL, some local authorities and the LGORU. It is however evident that it will be many years before anything approaching a complete answer can be found. Our concern has largely been with this interim period.

4. Existing standards of maintenance are so varied that adoption of a defined set of standards however tentative must improve the situation. Experience abroad confirms that only when defined standards are uniformly adopted can progress in developing highway maintenance techniques and management be made. We therefore considered it of the highest importance to provide a starting point in the form of initial standards definable in the present state of knowledge and techniques. We have devoted a good deal of our work to this end, greatly helped by the RRL. The initial standards will, we hope, by a process of continuous trial and study be gradually transformed into the firmer, more comprehensive and more scientifically based standards which should remain the long-term objective.

Present Maintenance Standards

General

5. Expenditure, which ultimately controls maintenance standards, is often determined rather by the inter-action of human judgments and political forces than from a detached and rational appraisal of needs. Within the limits thus imposed maintenance standards are at present based largely on the local engineer's discretion. Standards of individual functions are rarely defined. The result is that maintenance practice varies widely between authorities, with a wider variation in standards between urban roads than between rural ones. Clearly some authorities are using either unsuitably high or unsuitably low standards.

6. Variations in the level of available funds affect standards, particularly those of carriageway maintenance, because they determine whether long-term measures or short-term measures—possibly more costly in the long run—are adopted. The present state of the road network is largely a function of its treatment in earlier years. Restraints on expenditure seem in many cases to have prevented maintenance policies from being sufficiently forward-looking to prepare for modern traffic.

Structural Standards

7. The following are our more important conclusions on current standards:—

a. Structural standards are lower in relation to need than standards for other maintenance functions.
b. In times of financial stringency maintenance of carriageways suffers most.
c. Increasing use of short-term palliatives such as patching, or surface dressing as an alternative to resurfacing, is causing a gradual structural deterioration of carriageways, particularly of those with heavy or increasing traffic flows.
d. Very few authorities set out to identify areas of poor skidding resistance in advance of accidents.
e. The fixed frequency approach is not the most appropriate for structural functions; a more flexible approach based on need is preferable.
f. Inspections of carriageway conditions are often inadequately organised, with no proper documentation or procedure for follow-up action.

Standards of Aids to Movement and Safety

8. We draw attention to the following specific points:—

a. The organisation and execution of snow and ice clearance and presalting vary as greatly as those of other maintenance functions.
b. There is a balance, calling for great experience and nice judgment, between the need for a quick response to a frost warning and the need to avoid costly and unnecessary salting trips. The practice of keeping labour standing by at depots to deal with emergencies caused by snow and ice can be overdone and should be periodically reviewed.
c. Surface road markings and reflector studs can probably be most economically renewed at fixed intervals. Since contractors generally insist on waiting for work in quantity, there is often advantage in authorities setting up their

own specialist road marking gangs to carry out urgent replacements of obliterated markings. Several have already done so.

d. Many authorities scout too frequently for failure of street lighting and illuminated signs. Much must depend on the age of the installation and type of light source but the less frequent scouting generally carried out by rural authorities seems to be satisfactory.

Standards of Amenity Functions

9. No highway maintenance function serves only amenity. Grass cutting particularly, though largely regarded as an amenity, has a safety value in preventing obstruction of sight lines at bends and low traffic signs. The amenity aspect of sweeping is also predominant in the public's mind as is shown by the daily, even continuous, sweeping carried out in most town centres; this we appreciate but cannot accept the practice of one authority which spends over 30% of its maintenance expenditure on sweeping, mostly on unclassified roads. Grass cutting in many rural authorities and sweeping in urban areas could be reduced without detriment to safety standards. In times of financial stringency these activities should be restricted to the minimum in favour of other maintenance functions.

The Proposed Initial Maintenance Standards

Derivation of the Initial Standards

10. In arriving at the initial standards set out in Appendix 1 we first examined the criteria currently used to decide the work to be done, and studied the present distribution of expenditure between the various maintenance operations and between types of road. This fact-finding exercise proved no simple undertaking. It was carried out for us by the RRL in conjunction with local highway authorities as part of the Laboratory's proposed longer-term study of highway maintenance. The aims of the exercise were:—

a. To establish the existing standards for each highway maintenance function defined by the Committee (as in Chapter 2).

b. To establish the present annual expenditure per function.

c. To relate the standards achieved in various authorities to the expenditure per function in order to compare costs and value obtained.

d. To explore in the light of (a)–(c) above the possibilities of devising for general use a set of standards for each maintenance function.

11. The study was based on detailed data from 22 local highway authorities in England, Scotland and Wales. Brief descriptions of these authorities are set out in Appendix 7, which also includes some of the data and figures produced from the study. These show the wide variations in current practice. They also highlight the difficulty of collecting comparable data. A full report of this study accompanied by a good part of the data is to be published by the RRL. Highway authorities will find it a most useful document.

12. Although there is a need for continuing study and development to achieve a system of scientifically based standards, it is clear that it will be a considerable

time before these will be produced. Since further real progress depends on the adoption of uniform maintenance standards, we felt compelled to put forward firm proposals for *initial* standards. We urge their acceptance and adoption by all highway authorities until they can be improved and replaced. Uniformity of practice in all authorities will aid the empirical assessment of these standards and their refinement. We believe that it will also bring a more economic use of maintenance resources, although detailed financial and economic appraisals of the effect of the initial standards have yet to be undertaken.

13. The standards we propose represent in some respects a considerable advance on present practice and cannot therefore be fully achieved immediately. They are important however as guides for assessing the sufficiency or suitability of existing roads and the need for an increased maintenance effort. Their use for this in conjunction with maintenance ratings is explained in the next chapter. We expect that the initial standards may have to be used by highway authorities for some time, but we hope that in the future they may lead to more refined standards derived at least in part from objective measurements and economic assessments.

Explanation of the Initial Standards

14. The standards reflect two of our conclusions:—

(i) That present standards of structural maintenance need to be improved. We have avoided the concept of fixed frequencies and expected road surface life. The standards have been set in relation to conditions which can be measured on the surface. In most cases the structural standards are expressed in the same terms for all roads. Standards have been set for heavily and lightly trafficked roads to the extent that the deterioration of carriageways results from the volume and weight of traffic, the effect being proportional to the fourth power of the axle loading.

(ii) The present standards of certain non-structural functions seem to be excessive. The standards suggested for grass cutting and other amenity functions have been fixed at the minimum thought necessary for safety of passage and weed control. We believe that higher standards for amenity purposes are a matter for decision by local highway authorities; our standards provide a datum by which they will be able to make judgments about work required for amenity.

For non-structural maintenance functions separate standards have been set for different categories of road defined broadly as follows:—

a. Motorways and very important trunk roads
b. Other trunk and important principal roads
c. Other principal and important non-principal roads
d. Other roads.

We do not believe that a road's importance can be judged entirely on the basis of its official classification.

15. The initial standards are limited to the highway maintenance functions set out in Chapter 2. They indicate when maintenance should be done rather than

the form it should take and are not concerned with specific materials or techniques for applying them.

The Future of the Initial Standards

16. More refined or more scientifically based standards will not be quickly developed and an element of judgment will always remain. The purpose of defining standards is to assist those who take decisions by removing from the field of judgment as many aspects of the subject as are capable of measurement. We see standards being improved in a number of ways.

17. First, experience will suggest straightforward changes of level or method of setting out the standards in the Appendix. While we would not wish to see frequent changes of this kind, because over short periods of time stability can be a greater virtue than strict accuracy, we would expect that revision of some of the details would be worthwhile perhaps at intervals of not less than two years.

18. Secondly, increasing availability of data should lead to other simple refinements of method. For example it may become possible to relate standards more directly to vehicle usage which elsewhere in this report (Chapter 11) is shown to be critical to maintenance levels. Improved data may also enable the standards to be related in greater detail to types of road, their width or construction.

19. Thirdly, we foresee greater precision in forecasting the need for maintenance work as new apparatus is developed. Examples of recent developments are: SCRIM—the sideways force coefficient investigation machine—which measures the skidding resistance of the road surface; and the Deflectograph which enables the engineer to assess the appropriate treatment for a road by measuring the strength of the road structure. The computer-based motorway communications system will be used to monitor motorway temperatures and record and process other weather data. It will help those responsible to decide when salting should be done. We suggest that the Minister should make the information available for use on local highway authorities' roads.

20. Finally we look forward to longer-term studies designed to place maintenance standards in their economic and social setting. Virtually nothing is known at present about the optimum level of maintenance from the point of view of its value to the community though this is the only approach which offers a prospect of arriving at standards which will be accepted as objectively suitable. However, in some cases, such as snow clearance, pre-salting and inspection of road lighting, economic studies may well indicate objective standards within a relatively short time.

Conclusions and Recommendations

21. There is urgent need for generally applicable objective standards of highway maintenance but these can develop rationally only if a set of initial standards is adopted by all highway authorities.

Following are our RECOMMENDATIONS:—

a. The standards set out in Appendix 1 should be adopted and used immediately by highway authorities for the planning and management of their maintenance programme. They are not as a whole capable of being achieved immediately in all authorities. Roads should be brought up to these standards over a period of time, during which they should be regarded as targets.
b. Central and local government should co-operate to the full in the development of objective standards and both short-term and long-term economic studies should be simultaneously set in hand.
c. All highway authorities should make full use of the new apparatus now becoming available for the measurement of a road's condition, arranging if necessary to share more costly items.

Chapter 5: Allocation of Resources

Introduction

1. In this chapter we consider how to replace rule of thumb allocation of maintenance funds by methods based on specific data. We deal with the determination of the total amount and with its allocation to individual projects. Our comments apply however only to the allocation of funds to maintenance as defined in Chapter 2.

Present Practice

2. At present many authorities use a simple historical basis for deciding the total maintenance allocation; this can be summed up as "the same amount as last year plus an allowance for inflation". Such an approach ignores variations in traffic, road mileage and therefore the relationship between revenue expenditure and preservation of the asset.

3. We have three specific criticisms of current ways of dividing funds between different areas, roads or maintenance functions. First, total funds are sometimes allocated to roads on the basis of their classification. This may seem likely to produce a sensible result but does not do so. The usage and importance of roads often bear little relationship to their classification. Traffic flows on the quietest trunk roads are far less than those on some urban unclassified or Class III roads. The following Table, based on national traffic census figures for 1966, shows clearly that the classification system is an unreliable guide to a road's usage and therefore to its maintenance requirements:—

Traffic Flows on Different Classes of Road*

Class of road	*Rural*	*Urban*
	Vehicles per day	Vehicles per day
Trunk	500–30,000	2,000–32,000
Class I	150–17,000	700–32,000
Class II	100– 8,000	600–18,000
Class III	40– 2,000	300–16,000
Unclassified	30– 2,000	50– 8,000

4. Secondly funds are often allocated to areas simply on the basis of road mileage. This too is unsound. Allocation according to road mileage produces

*Appears as figure 3 in RRL report, LR 206.

anomalous results: for example the standards of surfacing achieved are noticeably uneven in authorities whose funds are allocated to divisions in proportion to their road mileage ignoring traffic flow.

5. Finally, allocation of funds both to areas and to certain maintenance functions is influenced too greatly by public demand. Highway maintenance, particularly in shopping or residential areas, is rightly a matter of public concern. There are however authorities where in our view pressure from the public is allowed to override engineering and economic considerations to too great an extent. This leads to excessively high standards of services and amenities and the allocation of insufficient funds for maintenance of the carriageway and footway. We hope that the suggestions in this chapter will improve the position.

The Future

Allocation to functions

6. Authorities face two main problems: how to assess objectively what the level of funds should be and how to spend the funds which are in fact available. Defined maintenance standards of the type discussed in the last chapter are essential for the satisfactory solution of both problems. They provide the basis for defining where maintenance will be needed in future if the standards are to be achieved and for assessing which roads currently need treatment.

7. In allocating funds for maintenance authorities need to consider functions under three headings:—

a. Structural;
b. Cyclic functions ie broadly covering aids to movement and safety, and amenity;
c. Winter maintenance.

Authorities will need to decide not only the total amount but also its distribution between the three headings above. If they are able to provide funds commensurate with estimates based on the proposed standards, their task is an easy one. Our investigations have however led us to believe that in many cases the standards will not be achieved without a substantial increase in current expenditure which many authorities may not be able to meet. Our initial standards will enable funds to be more precisely allocated over these headings. Authorities should ensure that they give full consideration to possible alternative courses and their implications before reaching their final decision.

8. The implications of alternative levels of expenditure under the headings of cyclic functions or winter maintenance are not too difficult to assess. Structural maintenance is far more complex. The highway is a wasting asset if not effectively maintained, and expenditure deferred now may lead to much greater expenditure later. Engineering and economic priorities are involved as discussed in the next section.

9. We would suggest that when authorities have provisionally decided the level of funds to be available for maintenance they should consider whether, having

set aside the funds required for the agreed standard of cyclic functions and winter maintenance, sufficient remains for structural maintenance. As a rough guide, based on an analysis of spending in the better organised authorities covered by the standards study, we believe that about 60% of total maintenance funds for rural roads should be available for structural work; on urban roads, where street lighting is a major expense, the proportion could be slightly reduced but should still, we believe, be no lower than 50%.

Allocation between Structural Projects

Engineering Priorities

10. The greater part of the current year's budget should therefore be available for structural maintenance work. There will probably be a number of structural projects which choose themselves by their urgency on engineering grounds alone. Engineers should however realise the risk of accepting too many projects on this basis: they will not have been subjected to the detailed scrutiny described below which we regard as a necessary step in assessing the urgency of structural maintenance projects. The money which then remains may be insufficient to cover all the other projects indicated by the standards to be necessary. Even if larger sums were available, standards would not however indicate the relative priorities of the various projects. Since funds are likely always to be limited, authorities therefore also require a sound system of determining these priorities.

11. We have studied one such system, sufficiency ratings, developed in the USA and modified for use here by the counties of Lincolnshire (Lindsey) and Leicestershire. Sufficiency ratings are primarily used for highway improvements rather than maintenance. Each length of road is regularly inspected so that its adequacy may be judged from a numerical evaluation of its characteristics eg surface, kerbing, alignment. The total of these evaluations, multiplied by a traffic factor, provides the rating. The roads with the lowest rating are given the highest priority.

12. The rating approach seemed also to be of great value for maintenance and we are grateful to Lincolnshire (Lindsey) and Lanarkshire County Councils for carrying out a sufficiency rating exercise to test the system's applicability on the ground. The RRL and the two county surveyors agreed that a rating system could be devised which would indicate the work needed to attain the proposed standards of maintenance and the priorities for doing the work.

13. Appendix 2 shows the RRL's maintenance rating system. The rating system involves first a field assessment of each road section the results of which indicate where and to what extent roads have fallen below critical levels of deterioration, defined to correspond to those in the proposed standards. Field assessments for rating purposes identify immediately the most critical structural maintenance projects. They also have the following incidental advantages:—

a. all roads are regularly inspected;
b. the findings are properly recorded;
c. the findings are on a uniform basis and could be compared for different lengths and types of road.

14. These advantages are available now to all authorities which introduce field assessments of their roads on the lines set out in Appendix 2. The expense of setting up this system will not be high and updating the information thereafter will cost little. Experiments in two authorities suggest that two technicians assessing roads for this purpose can cover 5 miles a day. The additional cost would be amply justified because value for money can be obtained from maintenance work only if the workload is properly assessed before a programme is fixed. We RECOMMEND authorities to use a maintenance rating system as the basis of regular, documented inspection of all their roads in the manner set out in Appendix 2.

15. The second stage of the rating system involves the refinement of the field assessment by weighting both the characteristics assessed, eg deformation, camber, according to their relative importance, and the road sections as a whole, according to their traffic flow. The calculations are well suited to processing by computer. The resulting ratings would be comparable both between the characteristics and between different road sections. The weighting factors for the characteristics given in Appendix 2 are still arbitrary but authorities can use them to refine the field assessments within single road sections. Factors suitable for different traffic flows however have yet to be developed and the RRL plan to give priority to this. We suggest that until national factors for traffic flow are available authorities should devise and use their own. Appendix 2 shows how the field assessment and the calculation of the final rating should be carried out.

Allocation Between Structural Projects

Economic Priorities

16. Standards provide the basis for the rating system which indicates in terms of engineering priority the road sections most in need of treatment. Authorities should cost the treatments indicated by the rating system for the priority road sections until the sum of these exhausts the available funds. Having thus defined the sections on which work might be undertaken, authorities should then assess the economic priorities. To do this they must consider suitable and cheaper alternative treatments of each such section as demonstrated in Appendix 3. The examples in the Appendix use the central government discount rate; there would be major advantages of consistency and comparability if all highway authorities were to adopt this rate. The Appendix also emphasises the possibility of reconsidering the allocation of funds to amenity and cyclic functions if the assessments suggest that more money could justifiably be spent on structural projects.

17. These assessments, which are designed to disclose the most worthwhile form of maintenance for the sections concerned, should be based upon a long term improvement plan which must be taken into account in making decisions on what maintenance should be undertaken on a particular road. If there is no forthcoming improvement, the economic effects of alternative maintenance treatment should be compared: for example resurfacing at once as against surface dressing followed some years later by resurfacing. It may also be more economic to carry out an improvement rather than extensive maintenance

especially if the carriageway width is sub-standard. If however an improvement is expected, the effect of delaying the maintenance and combining it with the improvement should be fully assessed.

18. The technique of economic assessments implies the existence of a maintenance programme extending beyond a single year. Though the level of funds available for maintenance in subsequent years will not be precisely known, we believe that a firm programme for about three years forward, based on a reasonable set of assumptions, can be prepared. Such a programme, together with the long term improvement plan, which could cover a period up to 10 years ahead, will provide authorities with an adequate basis from which to consider the alternatives.

19. Engineers will, in compiling the three year maintenance programme, have to assume the likely future pattern of events. This will not be easy since there is no tradition of estimating future maintenance expenditure over such long periods. The estimates will therefore be a matter of judgment based on the best available information. The economic assessments, which enable immediate decisions about individual projects to be based on their relative value, will need to be made from year to year in the light of the most up-to-date information. The forward assumptions made for the purpose of assessing economic value do not constitute programmes, but are aids to decisions falling to be made at budget time. They will improve with experience and will become easier to make when all major roads are constructed to modern standards. We RECOMMEND:—

a. that authorities should produce firm three year maintenance programmes based on longer term improvement plans.
b. that authorities should use economic assessments to determine the relative priorities of structural maintenance projects.

The Financial Year

20. A three year maintenance programme would have the added advantage of overcoming the tyranny of the financial year. Some highways departments plan maintenance year-by-year because their efforts are concentrated on spending in each financial year precisely the funds allocated. The consequence may be a rush to spend funds quickly before the end of the financial year which may not represent the best way of spending the money. Some authorities avoid this situation, for example by allowing carry-over of entitlement to funds. We believe that there is no need for authorities to insist that expenditure should match the estimate by a given date. Indeed rigid accounting of this kind precludes three year maintenance programmes.

21. We envisage the carry-over of schemes as a means of enabling specific maintenance jobs, for some good reason not completed in the year, to be carried out later without affecting future projects. We are not suggesting the carry-over of funds for which no immediate need or justification can be seen, such as unused winter maintenance funds. We RECOMMEND that authorities should operate the budgeting system in a way which avoids the end-of-year problem and permits the introduction of rolling, perhaps three year, budgets for maintenance.

Points for Further Study

Maintenance rating system

22. As explained earlier, the maintenance rating system set out at Appendix 2 requires further development before it can be fully applied. Development of the rating system should be undertaken centrally in order to ensure comparability between authorities; this is particularly important in the context of trunk roads which will be assessed for rating purposes by different agent authorities. We RECOMMEND that the Road Research Laboratory, the government departments and local authority associations should co-operate in a series of practical experiments over a wide variety of roads and areas to develop the full maintenance rating system for general use as soon as possible.

Valuation of Roads

23. A pilot study to establish a method of calculating by a formula a road's value to the community and to consider the implications of this value for the allocation of maintenance resources was carried out for us by the Local Government Operational Research Unit. Details are set out in Appendix 9. The Unit defined the value of a road as the cost which the community would incur, for example from increased journey times, if it did not exist. They then attempted to derive a formula which would produce this value by reference to factors such as traffic flow, road width and density of local population.

24. The pilot study leads us to two conclusions. The first and principal of these is that traffic flow is by far the most important factor in any calculation of road value. This is in line with the conclusions of our other studies which have indicated the importance of traffic flow in assessments of maintenance needs. It suggests that the further development of traffic factors for the rating system will enable the system broadly to take account of a road's value in determining priorities. The second, rather more tentative, conclusion is that the value of some minor roads is so low that the justification for maintaining them in a traffic-worthy state is questionable. We have been advised that it would be economically valid to regard the road value figure as the maximum justifiable annual expenditure on maintenance on the link concerned.

25. The approach adopted in the study can be applied only to rural areas since urban situations are too complex for the method of hypothetical traffic reassignment involved. We have nevertheless concluded that the formula approach to road value could indicate the maximum justifiable maintenance expenditure on some minor roads. We therefore RECOMMEND that a further study should be made to investigate in greater depth methods of estimating a road's value in order to assess more precisely the importance in this value of factors other than traffic flow.

Management Aids

General

26. Much attention is currently being devoted by central and local government to new methods of deciding resource allocation. We believe that many of these

management aids, which all aim to ensure the optimum use of limited resources, could prove useful in the field of highway maintenance. They provide for a more rational approach to the use of resources by clearly defining the objectives, examining alternative ways of achieving them, assessing the costs and benefits of the alternatives and examining the actual output achieved in terms of the original objectives.

27. There is no single management aid which adequately deals with this new approach to public spending. The approach is a combination of several techniques, for example programme budgeting, discounting, cost benefit analysis, output budgeting, and it is advisable that authorities engaged in the field of highway maintenance should ensure that their staff take full advantage of these techniques.

*Output Budgeting**

28. Many of the new techniques may be expected to contribute to the improvement of maintenance management. We have already discussed the benefits authorities could obtain straightaway by the use of discounting. For the future we regard the development of output budgeting as particularly important. Output budgeting is in a very early stage of development in this country but is attracting increasing interest, as for example in the House of Commons Select Committee on Procedure.[8] In this approach the resources, in the form of personnel, supplies and so on, expended in each of the activities identified are plotted against the output achieved. It is then possible to consider how variations in the quantity and proportions of the inputs are reflected in the quantity and proportions of the outputs and so to introduce controlled variations in order to achieve the desired objectives more effectively.

29. In highway maintenance the inputs for each maintenance function would be the expenditure on the resources devoted to it. The outputs would vary from preservation of the asset to less tangible benefits such as improved safety, less wear and tear on vehicles and time-saving. The difficulty will be to decide how much of these outputs is attributable to maintenance, to allocate them to the appropriate functions and to put a value on them. Only then might it be possible to assess which maintenance activities produce less benefit than their cost and to act upon that knowledge. The Ministry of Transport and some local authorities are working on this project and some progress has already been made. A great deal of study will be necessary before a reliable method can be established but in our view this research is of great importance since the development of output budgeting must be a major part of the research into objective maintenance standards. We RECOMMEND that in the continuing research into the application of output budgeting to maintenance the local authority associations, the professional institutions and the Ministry should co-operate in a series of practical studies.

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*The term 'output budgeting' is used specifically here. It is not intended to cover the wider field of Planned Programme Budgeting.

Chapter 6: Labour Productivity

Introduction

1. Much of our report is concerned with productivity, that is with ways of making the best use of men, materials and equipment. Labour productivity is however a complex, sensitive subject which is also urgent inasmuch as the large and obvious gap between the performances of the best and worst authorities indicates that substantial and immediate improvements should be made. We therefore devote a special chapter to this topic. Our conclusions, based upon wide enquiries, owe a great deal to the experience of those authorities who have developed work study and incentive schemes. They must be read together with other parts of our report, especially those concerned with planning, management and training, for only within an efficient setting can the full potential of labour be achieved.

2. We believe that labour control based on work study schemes, tailored to local requirements and coupled with incentive arrangements, is the best available way of improving labour productivity. Such schemes cannot however become universal for some years because they so often have to be preceded by an overhaul of the organisation and have to be devised by work study officers who for the present at any rate are in short supply. Equally important, many local authorities are not yet convinced of the need to control their labour in this way. They are therefore not taking the necessary steps to prepare for work study. Local authorities' present plans suggest that in 1972 about 50% of local authority manual workers will still not be covered by a long-term productivity scheme.

How to Test Efficiency

Purpose

3. Only if authorities can test the efficiency with which their maintenance is carried out will they be persuaded that it can be improved. A quick test was therefore required to convince them of the need to start preparing for work study as soon as possible. The standard times for carrying out specific tasks which form part of any work study scheme seemed the best available measure for this purpose. Since standard times tailored to local circumstances take a considerable time to develop, we thought that national standard times for individual maintenance operations which could be compared with local actual times might serve in the interim. We can offer such standard times. They are set out in Appendix 4 which shows how authorities can calculate their level of productivity, or *Effective Performance* (EP). The EP is expressed in terms of a scale 1–100 based on times taken when work is done at incentive pace. Urban authorities should achieve 75 and counties, having more travelling time, about 70.

4. We accept this relatively simple and unrefined measurement because we consider it important to put in the hands of local authorities a quick method of testing broadly their own performance. This measurement should serve two purposes. It should demonstrate the extent to which labour productivity can be improved. It should also be useful to local authorities in subsequent negotiations on increasing productivity because they would have a better idea of the position from which they are starting.

Derivation of National Standard Times

5. Data for the compilation of national standard times fortunately exist in those authorities where work study already operates. Our consultants were able to derive standard times for a wide variety of highway maintenance activities from their data bank of work measurement accumulated in over 100 authorities. The operations set out in the Appendix have been broken down into simple categories which would be consistent for all authorities. The method employed in any particular authority has been ignored, the assumption being that the method of working used was the appropriate one for the job. This may not necessarily be so. Authorities using the figures in the Appendix should not therefore infer that the method for which standard times are given is necessarily the best one. For example the standard times include grass cutting with a scythe as well as by machine and sweeping done by hand as well as mechanically.

6. Standard times for each operation were calculated by taking the average for all authorities for which the consultants had information in their data bank. They then compared the results with actual times in fifteen authorities having work study. They found that the standard times enable authorities to obtain an estimate of labour productivity with a 95% degree of reliability by using a sample of approximately 450 man hours of work. Some of our members have confirmed this by tests in their own authorities.

Limitations of the Method

7. The following qualifying factors should be borne in mind:—

a. The method gives only a broad indication of the overall picture. The work content of what is apparently the same operation varies greatly between authorities. The method could not therefore form the basis of an incentive scheme, for which these standard times are not sufficiently detailed. Nor should it be applied to single operations or small groups of workmen for it cannot be used to compare productivity at this level.

b. The apparent scope for improvement may tend to be understated because—
   (i) special active interest in the employees' work by management during the period of initial measurements tends to increase productivity if only temporarily;
   (ii) supervisors will make a particular effort when measurements are being taken to achieve a reasonable performance figure;
   (iii) better workers tend to be selected for the exercise rather than a truly random sample.

Recommendation

8. We RECOMMEND local authorities without work study facilities to measure their productivity by the method set out above, using the figures in Appendix 4. They should do so within six months of publication of this report.

Work Study as Part of Efficient Management

9. The institution of work study and incentive bonus is a relatively long-term task which must be done authority by authority. There is no short cut, though preliminary experience of work measurement will help. We therefore believe that measurement of actual productivity levels using nationally calculated standard times is a step towards full work study techniques and incentive bonus schemes related to local conditions and governed by more exact measurements.

10. Before work study and incentive schemes are introduced authorities should review their management organisation. Management methods and labour productivity are interdependent. Without efficient management labour cannot be used to full advantage nor can better labour productivity be distinguished from savings due to improvements in the organisation.

The benefit of work study and incentive bonus

11. The figures on the following page demonstrate the productivity improvements, generally above 50 %, which can result from the combination of work study and an incentive bonus scheme. They show changes actually achieved in the highway departments of 20 authorities. We do not doubt the value of incentive schemes coupled with work study. Their benefits are not simply the achievement of additional work for the same labour cost. The schemes also provide management with essential data on resource utilisation difficult to obtain in any other way. These data can disclose the need for changes in management methods and should be regarded as an important planning tool.

12. The costs of installation can be high. However although the benefits do not accrue immediately they too should, as the Table suggests, be high, so enabling the installation costs to be rapidly written off. The continuing costs are far less than the benefits achieved: these are not only financial and can include much reduced labour turnover and fewer complaints from the public. High quality supervision, ensuring a good standard of workmanship, is essential. Schemes should also be continuously monitored and regularly reviewed by each authority.

13. A limited survey undertaken by the RRL suggests that incentive bonus schemes have helped some authorities suffering from a high labour turnover to retain labour. We believe that work study based incentive schemes should not be avoided because labour turnover is low. Pressure from men and the unions for the introduction of incentive schemes, even if on the interim basis suggested by the NBPI (see page 32), is bound to increase.

Benefits of work study based incentive schemes*

Type of Authority	Increase in Productivity %	Increase in Earnings %	Reduction in Labour Cost %
County Councils	58	12	29
	65	17	29
	53	16	24
County Boroughs	112	28	39
	61	13	30
	50	18	22
	78	19	33
	95	23	37
	112	26	36
	43	13	21
London Boroughs	96	3	33
	62	18	27
Non-County Boroughs	41	3	27
	89	22	35
	50	26	16
	54	20	29
Urban District Councils	56	12	28
	97	24	37
	72	22	29
	72	17	32

*Table taken from report on productivity commissioned from PA Consultants Ltd.

Preparatory works and decisions

14. The introduction of incentive schemes should always be preceded by intensive education and discussion with elected members, staff and unions. Knowledge of the experience of local authorities already operating incentive schemes may help to avoid the strained relations between labour and management to which these changes sometimes initially give rise.

15. Many authorities will wish to utilise the extra labour power liberated by incentive schemes to do additional work if finances permit. Other authorities will face the problem of redundancy, on which advice has been given by the National Joint Council (NJC), the negotiating body for wages and salaries in local authorities. In their code of guiding principles they urge authorities to absorb the redundant labour in other departments if possible instead of opting for retirement with severance pay. The latter course can usefully be accompanied by consultation with the NJC on the terms to be offered. In either case the adoption of incentive schemes should be preceded by adjustments in recruitment policy to allow for changes in the planned labour force.

16. Among other matters of principle to be determined before discussions on details take place with the men or the unions are:—

a. whether staff who service manual employees eg storekeepers, drivers, vehicle and plant maintenance men, are to be included in the bonus scheme, and if not how they are to be rewarded;
b. the need to maintain suitable differentials between workers on bonus, their supervisors and site clerks;
c. the need for the incentive scheme to be sufficiently sensitive to reflect even small productivity improvements.

We are not in favour of the inclusion of supervisory staff in bonus schemes. We therefore welcome the restructuring of roadmen's wage groups decided in October 1969 by the NJC and the implied increase in differentials (see next chapter).

Recommendations

17. We RECOMMEND that—

a. individual authorities press ahead with work study for the reasons we have indicated, followed by incentive schemes.
b. the local authority associations should review the progress of work study based incentive schemes generally. This might be done in conjunction with the Local Authorities Management Services and Computer Committee.

NBPI Report No. 29

18. Our study on productivity must be seen against a background which includes the NBPI Report No. 29 'The Pay and Conditions of Manual Workers in Local Authorities, the National Health Service, Gas and Water Supply'[3] published in March 1967. We have found that its strictures on the productivity of local authority manual workers, though based on 1966 studies, still apply in highway maintenance. The criticisms centre on inadequacies of management. We too have found very great scope for improvement in management and we set out in Chapter 8 (Organisation) those aspects most in need of attention. Report No. 29 also cites lack of management training as an important contributory factor to low productivity. We endorse this very strongly and suggest in the following chapter how training could be improved.

19. Our present concern is with the NBPI view on incentive schemes. In arriving at their recommendations the Board encountered the same difficulty which we found when studying productivity, ie that incentive schemes properly imply full work study involving up to two years introductory work before the payment of incentives. Many authorities were not in a position even to start the work study part of the sequence which, in any case, presupposes up-to-date management. The position is still the same.

The NBPI's Interim Incentive Scheme

20. In view of the urgent need to secure increased pay for local authority manual workers in return for increased productivity the Board recommended an interim

incentive scheme, much as we have put forward an interim means of measuring productivity. It is known as *the Shorter Term Scheme* or *10 for 10.*

21. The broad principle is that a norm figure for total wages for a group of employees in a particular service would be considered in relation to a norm for total output; a significant drop in wages compared with output, or a significant increase in output compared with wages, would lead to a bonus payment. A 10% bonus would be paid in return for a 10% reduction in manpower costs. It could be introduced in two stages, the first being a payment of 5% bonus when the manpower cost saving had also reached 5%. The Board took the view that many authorities without work study could benefit from this interim scheme since it would oblige them to measure the use of their manpower and thus to rationalise their labour policies. At the time of Report No. 29 incentive schemes had been introduced in only some 40% of local authorities, and the functions of less than half the workers paid under such schemes had first been covered by work study. Among highway authorities the proportion who have introduced work study or incentives is still less than 20%.

22. Following the NBPI's report the NJC Work Study Group appointed consultants to devise a system for operating an interim bonus scheme. The NJC have now published a report[9] advising authorities how they might go about the installation of an interim scheme. Experience to date suggests that interim schemes need take only 3 months to install or about 9 months in those authorities which have to reduce their labour force.

Interim Schemes—general comments

23. An interim incentive scheme can be operated by clerks without experience of work study. It offers authorities a simple means of securing a return for the increased wages they are being pressed to provide. Authorities who do nothing are also likely to be obliged to increase wages but with no corresponding return. We cannot emphasise too strongly however that authorities who adopt an interim scheme must simultaneously press ahead with the appointment or training of work study officers and the implementation of a full scheme. Under the terms negotiated by the NJC, and to which the unions and men have agreed, authorities are committed to transfer to a more permanent scheme as soon as possible after introducing an interim scheme. This is in the employees' interests if only because an interim scheme at present restricts bonus to a maximum of 10% while under a full scheme it could rise to $33\frac{1}{3}$% or more.

Transplant Schemes

24. There is one other means of rapidly installing incentive schemes. This is the transplant system originally devised by the County Surveyors' Society Work Study Advisory Group. Transplants were designed particularly for county highway departments where only a few incentive schemes are yet in operation. The essence is the 'transplanting' of data from an authority operating work study to one without it. The donor authority would provide data, train the

16. Among other matters of principle to be determined before discussions on details take place with the men or the unions are:—

a. whether staff who service manual employees eg storekeepers, drivers, vehicle and plant maintenance men, are to be included in the bonus scheme, and if not how they are to be rewarded;
b. the need to maintain suitable differentials between workers on bonus, their supervisors and site clerks;
c. the need for the incentive scheme to be sufficiently sensitive to reflect even small productivity improvements.

We are not in favour of the inclusion of supervisory staff in bonus schemes. We therefore welcome the restructuring of roadmen's wage groups decided in October 1969 by the NJC and the implied increase in differentials (see next chapter).

Recommendations

17. We RECOMMEND that—

a. individual authorities press ahead with work study for the reasons we have indicated, followed by incentive schemes.
b. the local authority associations should review the progress of work study based incentive schemes generally. This might be done in conjunction with the Local Authorities Management Services and Computer Committee.

NBPI Report No. 29

18. Our study on productivity must be seen against a background which includes the NBPI Report No. 29 'The Pay and Conditions of Manual Workers in Local Authorities, the National Health Service, Gas and Water Supply'[3] published in March 1967. We have found that its strictures on the productivity of local authority manual workers, though based on 1966 studies, still apply in highway maintenance. The criticisms centre on inadequacies of management. We too have found very great scope for improvement in management and we set out in Chapter 8 (Organisation) those aspects most in need of attention. Report No. 29 also cites lack of management training as an important contributory factor to low productivity. We endorse this very strongly and suggest in the following chapter how training could be improved.

19. Our present concern is with the NBPI view on incentive schemes. In arriving at their recommendations the Board encountered the same difficulty which we found when studying productivity, ie that incentive schemes properly imply full work study involving up to two years introductory work before the payment of incentives. Many authorities were not in a position even to start the work study part of the sequence which, in any case, presupposes up-to-date management. The position is still the same.

The NBPI's Interim Incentive Scheme

20. In view of the urgent need to secure increased pay for local authority manual workers in return for increased productivity the Board recommended an interim

Chapter 7: Training

Our Study

1. There can be few industries with an annual turnover of over £160m without a training scheme specifically designed for their employees. One of these is highway maintenance. Such training as there is forms part of the provision for highway construction generally and all our references to 'maintenance training' should be read in this context. The total provision is in no way commensurate with the size of the highway construction and maintenance industry. Clearly training, which we have considered in depth, receives far too little attention from local authorities.

2. There are two aspects of training which particularly prompted our study. First, training is essential to productivity. Present low productivity is probably largely attributable to the fact that few men at any level in highway maintenance organisations are specifically trained for the work they do. Secondly, training could also be of great importance when staff at all levels are faced for the first time with the idea of fixed standards of maintenance. North American experience has shown that there can be considerable opposition from lower management to the adoption of defined standards because of the conflict between the standard and the worker's personal judgment to which so much has till now been left. Similar problems might arise here with the adoption of the fixed standards which we recommend. However, authorities can through training set out to explain to all concerned why uniformity of standards is a necessary goal and, at a later stage, to justify the individual standards prescribed.

3. Our study has been based upon discussions with representatives of training organisations, examination of the syllabi of existing courses and the extensive knowledge of certain of our members. In addition the RRL, at our request, gathered information on training and qualifications from the highway authorities they visited, and the consultants' report included some aspects of training and staff management. Our belief in the importance of training is also confirmed by experience abroad.

Reasons for Present Lack of Training

Poor Image of the Work

4. The present inadequate training has several causes of which the key is probably the traditionally low image of highway maintenance work, which lacks the glamour attaching to the construction of new roads or bridges. The result is that highway maintenance tends to attract less enterprising management and young recruits are not forthcoming. This image could and should be changed.

5. To attract new younger entrants as roadmen authorities should make greater

efforts to offer a realistic career structure with systematic training for increased responsibility. They should present the prospects directly to school leavers, emphasising modern developments in plant and techniques, since mechanisation indicates the need for special skills and thus for increased earning capacity.

Small Differential between Roadmen and Foremen

6. The failure to present young recruits with an attractive career in maintenance has been partly due to the inadequacy of the wage structure. A characteristic of local authority highway work has been the small differential between the take-home pay of roadmen and foremen or craftsmen. The NBPI concluded in Report No. 29 that the small differential had been preventing men from seeking additional responsibility. The NJC therefore undertook a major overhaul of the wage structure of roadmen in order to create a far wider range of pay at this level which would be related to training in particular skills. Their proposals were finally agreed last October and notified to local authorities in Circulars NM 194 and 194B. They have now been adopted. In presenting this revised wage structure the NJC stated that authorities should regard it as the basis for a review of the pay of foremen, which is not fixed nationally. The provincial councils are now preparing to make adjustments in order to improve the position on differentials. We welcome the new wage structure as an important step in the encouragement of training at roadman level and urge authorities to use it as the basis for increasing the differential between roadmen and foremen as soon as possible.

Piecemeal Development of Highway Maintenance Training

7. Lack of maintenance training has also been due to the lack of a central body responsible for its provision. Courses for staff engaged on highway construction and maintenance at any level have generally been devised on a regional or ad hoc basis when the need became acute. Highway engineering qualifications from the elementary to the managerial are available but are currently provided by a number of independent and unco-ordinated bodies. Appendix 8 sets out the scope of the national organisations and details of the courses they offer. We have consulted most of the national organisations, and one regional one, concerned with maintenance training in England, Scotland and Wales and are grateful to them for their efforts to make clear to us exactly what part they play and for their suggestions on possible changes.

8. With the establishment of the national industrial training boards and more specifically, in England and Wales, the Local Government Training Board (LGTB) there seemed some hope that the incomplete patchwork of available training would be filled in. However a new situation has now arisen. Following a House of Lords decision it seems that local authorities may not be regarded as covered by the Industrial Training Act 1964 except in relation to activities they carry out on commercial lines.

9. This development is particularly unwelcome since highway maintenance training for local authority employees needs rationalisation. The Construction

Industry Training Board (CITB) had already made useful progress in encouraging training courses for construction workers and the opportunity was taken to include maintenance workers on some of these. It had offered the real possibility that training at all levels would be co-ordinated as part of a systematic development. However, interim arrangements have been made by the LGTB to ensure that national training developments will remain available to local government and the government has now presented a Bill to Parliament to bring local authorities once more within the scope of the 1964 Act. The rest of this chapter is based on the assumption that this or a similar statute will be enacted. We RECOMMEND that the government should ensure in the meantime that advances already made are not wasted.

Indifference of Local Authorities

10. A major reason for the lack of training is the apathy of employing authorities whose attitudes have for too long been conditioned by the old image of the work. The revised wage structure now offers the opportunity to make work in highway maintenance departments more attractive. Changing techniques of work make proper training all the more necessary. Some attention is paid to training for roadmen but many authorities consider that training on the job is adequate; training for supervisory or managerial posts on the other hand is too often thought totally unnecessary. This attitude is reflected in the acceptance by many local authorities of unqualified personnel for responsible posts.

Jobs for which Training is Required

11. Each local authority highways organisation covers a wide range of staff from the roadman to the engineer. The following list gives some idea of the levels involved:—

Engineer (Civil Engineering)
Technicians (with Civil Engineering qualifications)
Works Manager
Divisional/Area Foremen
Inspectors
Gangs:—Gangers/Working Foremen/Chargehands
Plant Operatives
Craftsmen
Roadmen

12. Training in the basic skills of road maintenance is not necessarily all a man will need in his career. Provision should be made for him to progress. At the outset any training scheme should make of a new recruit a *universal roadman* able to exercise all the skills and use all the light plant he is likely to encounter in the course of his work, which may include assignment to a functional gang. As a ganger or foreman he will later need not only to keep up with changes in practices or plant but also to learn how to supervise other men. Training is required by middle management in the skills related to management and

organisation of a block of work; since this calls for yet another technique, another training need is indicated.

13. An almost total lack of national data about the numbers of workers in each grade makes it difficult to assess with any accuracy the adequacy of the present training provision. One problem is that highway maintenance is not clearly distinguished from highway construction work. Moreover highway construction itself is not separated in national employment statistics from building and civil engineering construction. We suggest in Chapter 11 that this might be changed.

14. The following figures are based on information from two sources:—

a. county figures were provided by the County Surveyor's Society as the result of a survey carried out on our behalf.
b. county borough figures were part of the information gathered for the report 'Transport Planning: The Men for the Job'.[12]

They should be regarded as very broad estimates of the numbers of men at different levels working on highway maintenance in these two types of authority. We have no comparable figures for non-county boroughs or urban districts.

Maintenance Employees in Counties and County Boroughs

	Counties	County Boroughs
Operatives	20,000	7,000
Foremen and Gangers	3,000	1,000
Technicians	300	100
Engineers	700	200

Training Courses available and in Preparation

For Roadmen

15. A few local authorities run their own courses for trainee roadmen. Most of these concentrate on highways skills and light plant training. The four south-west counties' regional training scheme which has been in operation since 1965 is a notable example of local authority initiative in the training of highway workers. It provides not only basic and skilled roadcraft, plant operators' and drivers' courses but also, working in close conjunction with the CITB, heavy plant operators' courses. Training is given in modules as they are required and can be absorbed by roadmen. In addition there is the Roadwork 99 course offered by the City and Guilds of London Institute and nationally available in technical colleges.

16. The City and Guilds of London Institute have prepared a syllabus for a new advanced craft certificate in roadwork, which seems adequately to bridge the gap between Roadwork 99 and the IWHS courses (see next para). The new qualifications are intended for those engaged in highway construction and maintenance, particularly in local authorities, as an extension of the craft certificate and as a preliminary to further study by potential supervisors and inspectors.

For Foremen

17. Training for working foremen and supervisors is provided nationally by several bodies. The Institute of Works and Highways Superintendents (IWHS) has recently developed an 'affiliate' membership designed for working foremen and the courses they offer now provide training and qualifications in the skills likely to be needed at all levels from the working foreman to the general works manager. IWHS courses are available in several technical colleges, some of which also offer the courses of the National Examination Board in Supervisory Studies (NEBSS). The CITB offers training for working foremen and supervisors in its training centre at Bircham Newton and its basic and general supervisory courses have also just been made available in technical colleges and should eventually be taught in training centres. Several provincial councils run short courses for supervisors of manual workers on lines laid down by the LGTB. The south west counties' scheme also provides general and supervisory training for foremen and chargehands and includes a course run by a local technical college for the NEBSS certificate.

18. Both the CITB and the LGTB are planning further extensions of existing courses. They may also co-operate in a project for training workers in local authority highway departments. Assuming the present legal difficulties are overcome the CITB intend to set up training centres throughout the country, to be based primarily on the needs of local authorities. The existing south-west region counties' scheme, started by the highway authorities, will form one such centre and others are planned in Yorkshire and the West Midlands.

For Training Instructors

19. There are long-established courses for the training of training instructors in the *Training Within Industry* scheme run by the Department of Employment and Productivity (DEP). There are six courses, each lasting one or two weeks and covering topics such as leadership and job instruction. These courses prepare men on return to their authority to give instruction in supervision to the foremen and other supervisory grades. Authorities with too few foremen to justify their own training instructor can use the courses in instruction designed for foremen and organised by DEP's regional offices.

For Technicians

20. The engineering training and qualifications required by technicians can be obtained in several ways. The ONC and HNC syllabi and those of the IWHS cover the relevant subjects, and we commend the work of the Council for

Engineering Institutions in establishing standards and granting certificates to those qualifying for the national grades of technician and higher technician.

For Middle Management

21. For professional training there is an established pattern, though many authorities show a serious lack of interest in the continued training, both technical and managerial, of men in mid-career. There is as yet no tradition for managerial training. Very few management courses are run specifically for local authority employees and there was little evidence of central co-ordination in the development of such courses until the introduction by the LGTB of 3-week management courses.

Need to Change Local Authority Attitude to Training

22. Our main guide to local authorities' present attitude to training is the small proportion of their employees attending the available courses. The Table in para 14 gave figures for county and county borough employees; we believe that the number of operatives in all authorities eligible for Roadwork 99 for example exceeds 30,000. Rather over 300 men sit the examination each year. Supervisory courses tell the same story. Of the 20,000 local authority foremen in all forms of construction, 3,500 are members of IWHS; only a proportion of these can be concerned with highway maintenance.

23. Our own studies confirm local authorities' indifference to training. Very few of the authorities visited have regular arrangements for training their foremen, whether or not they require qualified men in supervisory posts. Training in management skills is even less in evidence. The studies suggest that among urban authorities those serving the largest population are the most likely to require qualified personnel in the lower supervisory posts but that in counties the employment of qualified men at these levels seems also to be associated with the operation of work study based incentive schemes. We assume that an increase in the demand for qualified men will follow increased application of such schemes.

24. We cannot emphasise too strongly that our recommendations can be effective only if there is a new attitude on the part of local authorities. They must acknowledge the need for their staff at all levels to receive specific training for the work they do. Even where this is provided on the job it needs to be carefully thought out and checks made to ensure that trainees are making the progress expected. In the past some local authorities might well have concluded that they could not meet the cost of training but with the advent of the industrial training boards and, in particular, of the LGTB, local authorities now have an incentive to make the maximum use of available training. The inaccessibility of courses, to which poor attendance and present lack of training is all too frequently attributed, is a symptom of local authority apathy, not a cause. If local authorities, possibly in co-operation with contractors, were willing to provide sufficient candidates for the existing courses, their local technical colleges would be able to offer the necessary tuition, subject to the availability of suitable instructors.

Instructors are of course produced where the work is done; local authorities will need to accept that members of their own staff may transfer to this role.

25. The risk that on qualifying the men will leave to work for contractors has tended to deter authorities from encouraging their staff to acquire formal qualifications. Authorities must take this risk if they are to improve the calibre of their labour force and should accept as part of their responsibility the need to offer sufficiently attractive career prospects to retain staff. To allow road maintenance training to fall behind is not the way to solve the problem of labour wastage.

Action Local Authorities should take

26. Authorities with limited establishments find it difficult to release staff (technicians to divisional foremen) for off-the-job training, yet training is so important that no establishment can be said to be adequate unless it allows for such release. Authorities can achieve this flexibility by assuming for example that staff in the training 'pool' will spend at least part of each year on training courses. We RECOMMEND authorities to adopt this or a similar approach to ensure sufficient flexibility to permit release for training.

27. Local authorities should play an active part in approving or suggesting changes in the syllabus and activities of examining bodies and training centres whose maintenance courses may otherwise be more suited to the needs of private contractors. It is equally important for authorities to adopt standard methods of carrying out maintenance work based on those which have been studied, approved and taught on roadmen's training courses. This will not only help trainees to be fully productive immediately on return from a course but will allow greater mobility of suitably trained labour.

28. In order to carry out these functions one person in each maintenance organisation, in addition to an authority's general Training Officer, should have formal responsibility for training and management development. Training need not be his only concern. This officer's role would probably be a co-ordinating one, in the sense that he would be responsible for knowing precisely what training was available and needed for maintenance work at all levels, both within and outside the authority, for co-ordinating the authority's own maintenance training programme and for ensuring that men were sent on the appropriate courses. We RECOMMEND authorities to appoint an officer in their highways department to this role.

29. Local authorities could also co-operate with local contractors in the provision of training as is already happening successfully in several areas. Such joint action may further diminish the risks of local authorities losing men to contractors. We RECOMMEND that more authorities should co-operate in this way.

30. Authorities should revise their recruitment policies and develop their own supervisors through systematic selection and training in order to ensure that all

supervisors and managers are suitably equipped for the job they propose to undertake. If all highway authorities made qualifications a requirement of appointment this would give added impetus to training schemes at staff level.

31. Enthusiasm on the part of senior officers is one of the most effective factors in encouraging staff to learn further skills or the latest approach to the job they already do. Those in supervisory and managerial posts should be made formally responsible for assessing the training needs of their staff and for encouraging them to attend the relevant courses.

32. Too often authorities feel obliged to send someone on training courses but have inadequate information to judge who would benefit most from them. Authorities should overcome this by discussing regularly with all staff their progress, their future training needs and how far past needs have been met. For higher grades staff assessment is covered by national agreements with the relevant staff organisations; in other cases authorities will need to make their own arrangements. But we should hope that the present arrangements would not stand in the way of the regular appraisals and discussions with individuals which we have in mind.

33. Finally we would make a few comments on general points of staff management which link up closely with all we have said about productivity and efficiency in highway maintenance. Training of local authority staff will be fully productive only when it is seen that promotion depends on individual achievement or promise and that posts are filled by the best candidate. Yet in studying maintenance organisations our consultants were struck by the tendency to promote by seniority and the occupation of senior posts by those no longer able to do the job.

34. The valuable report[1] of the Mallaby Committee discusses at some length many of the topics covered in this chapter and we endorse its relevant recommendations. In particular we would commend the statement about freezing pensions and early retirement for officers: "We consider that the right of the employee to retire earlier than at present should be accompanied by the employer's right to insist that an officer should retire if the efficiency of the service requires it". There is still a strong belief in local authorities, particularly those in areas of relatively high unemployment, that their social duty requires them not to make men redundant; the consultants found that maintenance seems to be particularly affected, since some authorities tend to regard it as providing suitable work for men who cannot make a valuable contribution elsewhere. This attitude is indefensible if greater efficiency is required.

Conclusions and Recommendations on Training Courses

General

35. Interest in the training of local authority employees has greatly increased with the establishment of the LGTB and the industrial boards. The situation remains however that the vast majority of those doing or organising highway maintenance are inadequately trained for their jobs.

36. For many grades suitable training is available and should be taken up. The totality of courses available for roadmen and supervisors, however inadequate its present distribution, now offers the young entrant a related sequence of training up to the level of works manager. The position is illustrated in the diagram on the next page. The following paragraphs discuss the need to fill some remaining gaps and to inaugurate a major programme of training for management.

For Roadmen

37. There is no generally available basic training suitable for all roadmen. Such training as is given is made more difficult by the lack of a suitable maintenance training manual. Existing manuals are either very detailed, very advanced or out of date in technical aspects. The reason for the small number of candidates for the Roadwork 99 course is that it is mistakenly considered too complex for the average roadman. It certainly covers the practice and theory of more crafts than many, especially the older, entrants to roadwork need, but in some authorities we note its satisfactory completion by large numbers including older roadmen. The craft aspect of the training is particularly valuable. We find that the course is most appropriate for masons, paviors and other craftsmen and for young men as a means of progressing to supervisory studies. The introductory General Construction Operations course offered recently by the CITB does not at present cover roadwork though if it were so changed and extended, it might provide the basic training now lacking.

38. We RECOMMEND:—

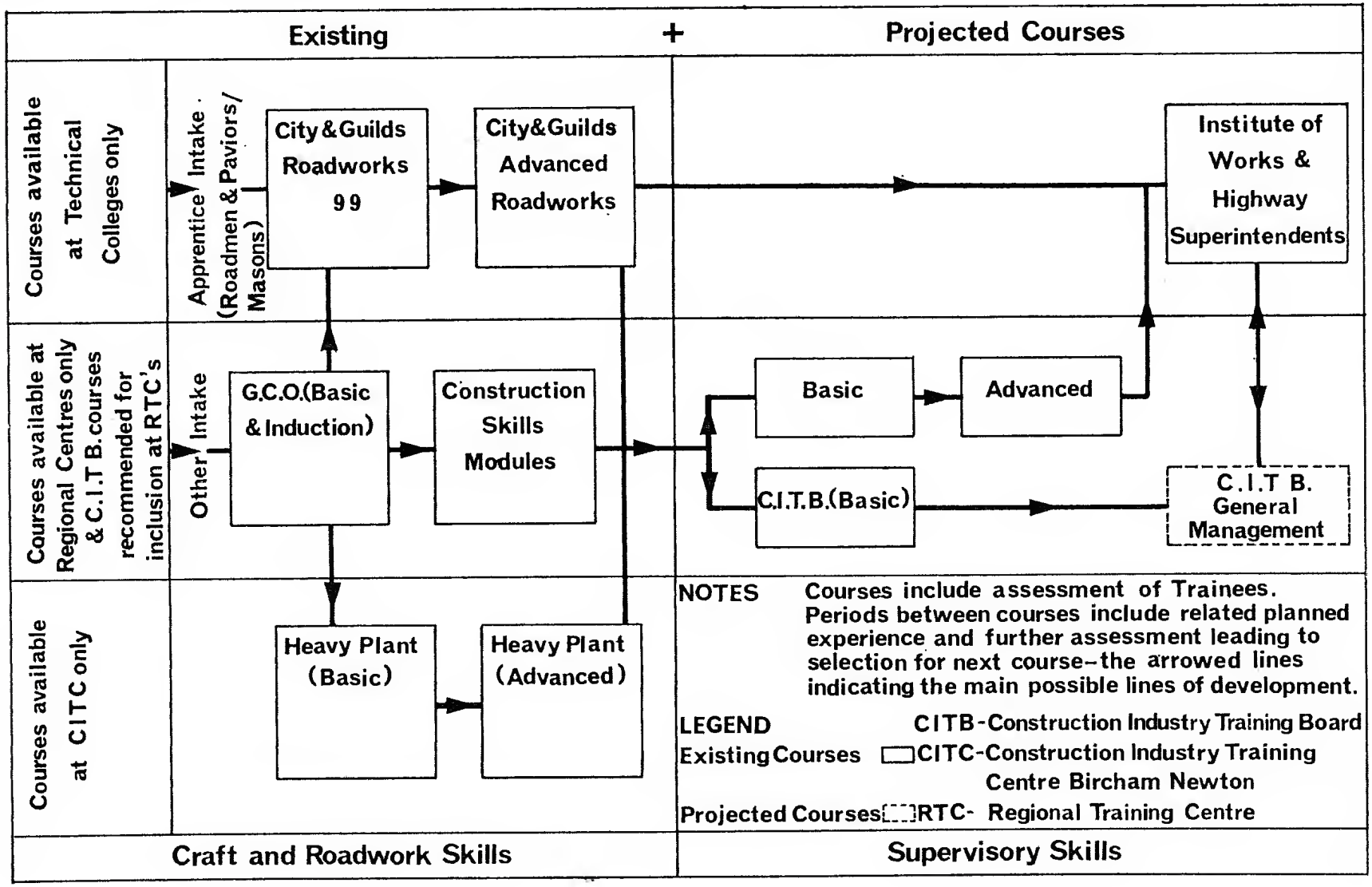
a. that Roadwork 99 be used primarily for young entrants who intend to specialise in a craft or to proceed to a supervisory post.
b. that a basic roadwork course be made available to far greater numbers than at present.
c. that more practical training in modules of individual skills be devised for older entrants.
d. that the Ministry should join with the local authority associations to commission a simple graphic training manual for roadwork: we emphasise *graphic* because we think both the subject and the trainees suited to this method of presentation.

For foremen

39. Local authorities are not making sufficient effort to train their foremen. The increasing awareness of the training need at this level is indicated by the extension of existing courses and the establishment by the LGTB of a working party on the subject. We hope that local authorities will encourage existing and potential foremen to take up the new opportunities.

40. The City and Guilds of London Institute's new advanced craft course seems adequately to fill the gap between the Roadwork 99 and the IWHS courses, which themselves not only provide qualifications recognised by local authorities and professional institutions but have the advantage that those holding them can release chartered engineers for other duties. At present authorities do not

Fig. 1. Training Programme



take the maximum advantage of supervisory courses whether run by the IWHS, the CITB or provincial councils.

41. For foremen's training we RECOMMEND:—

a. an increased provision of courses;
b. far greater encouragement to those eligible to attend them;
c. that the LGTB and CITB should proceed as quickly as possible to establish the proposed regional training centres. We would hope that the Boards might provide a timetable for their planned expansion of training since it is they who have most scope for improving the present situation.

For Training Instructors

42. Authorities should co-operate to take the fullest advantage of the courses available in the Training within Industry scheme.

For Technicians

43. In addition to the technical training generally available for technicians authorities should make greater efforts to introduce them to management techniques. Technicians should be encouraged to attend courses on management techniques and staff management.

For Middle Management

44. The training most needed and least available is that for middle management. This is an area where local authorities have lagged behind private industry, largely from a failure to recognise the need for management skills at higher levels in their maintenance organisation. The balance between the needs for professional and managerial training should be assessed for each individual by analysing his job, but it seems that management is still not regarded as a serious field for study by some senior officers in local government. However the NBPI report No. 29[3] stressed the need for much more extensive training in management and said that it should be embarked upon immediately as a matter of the utmost importance. We have certainly found that it is instruction in managerial skills which those in charge of maintenance most often lack. To emphasise how large a part managerial responsibilities play in such jobs, we include at the end of this chapter a typical job description for the senior maintenance engineer. This illustrates the predominance of organisational skills, personnel management and understanding of control systems over engineering knowledge. As highway maintenance work is carried out within the wider context of the local authority administrative organisation, the most senior officers concerned with highways should form part of central management teams and be fully versed in the latest overall management techniques. Indeed we believe that it should be possible to promote to some management posts those without engineering qualifications if they have other relevant experience.

45. As a guideline we suggest that authorities should aim to release staff at this level for an average of at least five days management training each year. Professional engineers should be sent with other senior officers from local

government on advanced management courses, such as the ten week courses run at Birmingham University and the three week courses sponsored by the LGTB, and they should also have greater opportunities to attend refresher courses in their specialist field. Authorities should be more prepared to take advantage of engineering and management courses run for other bodies, such as that being launched by the University of Warwick for the public sector generally. At present local authority representation on such courses is minimal. If highway maintenance is to achieve a status which will attract staff, it is essential that its officers should be as well trained in management techniques as those in other departments. We hope that the LGTB, which is now actively engaged on the question of management training for local government, will ensure that staff concerned with highway maintenance participate as fully as others in any new developments.

Specimen Job Description

TITLE: Divisional Engineer

RESPONSIBLE TO: Senior Maintenance Engineer (Deputy Borough Engineer or Assistant County Surveyor)

NECESSARY QUALIFICATIONS: Professional —Chartered Engineer
Requirements—Management training and experience. Capacity for leadership and judgment. Ability to communicate and to apply logical and analytical approach to managerial duties.

Principal Responsibilities

1. The preparation of the highway maintenance programme by organisation of work in the division for the survey and ascertainment of needs and priorities in maintenance taking into account the resources available.

2. The organisation, supervision and control of direct labour and other resources to ensure efficient execution of the maintenance programme.

3. The planning and progressing of work against programme commitments and the preparation of progress reports required for management purposes and budgetary control.

4. Operation and review of systems for the control of quality of materials and workmanship.

5. Management of the depots under his charge, safeguarding the assets eg against theft and wastage; institution, review and operation of systems for ordering, issuing, accounting and costing of stores, for controlling, accounting and costing of plant, vehicles and labour.

6. Control of the work of supervisors and workmen engaged on highway inspections and the administration of the Public Utilities Street Works Act; following up complaints and safeguarding the highway where frontagers' or statutory undertakers' works are in progress.

7. Discipline, safety and welfare of men under his control.

8. Maintenance of liaison with other departments within the authority, with other technical divisions of the engineer's department and with the police and fire authority as necessary. Knowledge of action required in emergencies in order to take personal command in accordance with the standing instructions.

9. Representing the Chief Engineer at meetings.

10. Dealing with landowners and the general public regarding the day-to-day activities of the department.

Chapter 8: Organisation and Administration of Work

1. If maintenance is to be carried out efficiently, the directing organisation and the composition of the groups who carry it out need as much attention as the direction itself. In this chapter, based largely on the consultants' report, we consider maintenance organisations both from within and in their relations with contractors and materials suppliers. Our recommendations are in the main of a general nature and are not geared to any particular pattern of local government. They are not therefore contingent on expected changes in the present structure.

The Maintenance Organisation

Structure

2. An effective organisation structure needs to be appropriate for the work to be done and must have simple lines of authority, responsibility and accountability and clear channels of communication. The right framework is an essential of sound administration but does not in itself guarantee efficiency. In authorities lacking an appropriate organisation structure, understood by the staff concerned, the general standard of management is noticeably lower than the average. Unsatisfactory organisations may result from a wide range of factors of which the following are typical:—

a. men not knowing to whom they should report;
b. men being simultaneously responsible to several superiors for the same operation;
c. managers being held responsible for events which they have not the authority to control;
d. too many or too few subordinates reporting to one man.

3. Differences in local conditions and geography between highway authorities mean that no single organisation can be recommended for all authorities, although those in which a single officer is responsible for the co-ordination of the total maintenance effort make better use of their resources than others. We RECOMMEND all authorities to reconsider their maintenance organisation in the light of the comments above.

Size of Divisions

4. Too many counties have a large number of small divisions. We judge them uneconomic because divisional surveyors in the most efficient authorities can exercise adequate control over larger areas comprising about 400–450 miles of road. We RECOMMEND that divisions in areas of average road density should not be smaller than this.

Definition of Responsibilities

5. Delegation of responsibility for the execution of maintenance to divisional surveyors (or equivalent) is understood and practised in most authorities. In some however the senior staff do not check sufficiently that delegated responsibility is leading to the right decisions by the right officers. Adequate definition of responsibilities is the key to decisions being taken at the right level. Uncertainty about the level at which decisions should be taken suggests that responsibilities have either been insufficiently thought out or have not been clearly communicated to those concerned. We RECOMMEND the use of up-to-date written job descriptions for each member of the management staff.

Standing Instructions and Routines

6. The better managed authorities all tend to use standing instructions for both routine and emergency maintenance tasks. These fall broadly into three types:—

a. Standard methods of repair, such as patching.
b. Emergency plans, such as snow clearance routines and routes.
c. Standard procedures, such as those to be followed in tendering and contracting.

This is the most efficient way to organise maintenance operations which have fixed patterns. We RECOMMEND authorities to produce sets of standing instructions in terms appropriate to the grades of staff for whom they are intended, to keep them up to date and to see that they are used.

Staffing

Use of Technicians

7. Chartered engineers are often employed on work which could competently be done by qualified technicians. There is much day-to-day administration with which an engineer should not need to concern himself but which would nevertheless be outside the scope of a foreman's responsibilities. Technicians can fill this gap. They can interpret for the foreman difficulties the latter may encounter in the engineer's instructions; they can also investigate complaints made by the public who accept technicans in place of the engineer as the Council's representative. The need for greater use of technicians was emphasised in the Mallaby Report[1]; more recently 'Transport Planning: The Men for the Job'[12] showed (see Table on page 38) that there are generally two engineers to every technician and we endorse that report's conclusion that the opposite should be the case. We RECOMMEND authorities to employ a much greater proportion of technicians and to offer them suitable training and attractive career prospects.

Flexible Use of Labour: Winter Maintenance

8. Authorities need to be far more flexible in their use of labour. They should be more willing, in allocating staff complements, to allow for the sharing of labour between suitable divisions or even departments. Reduction in the number of divisions would itself increase flexibility of labour usage but the possibility of

labour-sharing between departments should be borne very much in mind. It was mentioned in NBPI Report No. 29[3]; we endorse it as a means of ensuring that short-term lack of work in one section does not inevitably lead to idle time.

9. For winter maintenance this flexibility is particularly important. The need to provide a 24-hour winter maintenance emergency service is a complicating factor in assessing labour needs and authorities have a range of different policies. At one extreme are those who overstaff for much of the year on the grounds that they need the men for winter maintenance; at the other are those whose staffing policy takes insufficient account of the need for the winter service. Both these extreme policies are wrong. Highway departments' permanent staff should not include men who would be under-employed for part of their time. For the winter emergency service they should either borrow men from other departments or recruit additional temporary labour.

Gang Sizes

10. There is much evidence of gangs too large for efficient working, with some men therefore not fully employed. Many authorities have fixed gangs, often of five or six men in each but in a few cases of up to eleven. Flexibility must again be the guide. There should be no fixed gangs other than for specialist functions and groups should be assembled as appropriate for the job; the worst situation is that of large, fixed gangs. Most maintenance work apart from resurfacing or surface dressing operations can be efficiently done with gangs of three men or less.

11. A recurrent feature in the work of direct labour forces is the need to execute isolated items of urgent maintenance work because contractors find them uneconomical and prefer to wait for a block of work to accumulate. The only way authorities can undertake these jobs economically is by functional gangs, who have a full work programme but whose schedule can if necessary be altered to cope with the specific and single tasks which will not wait. Several authorities are already doing this.

Work Planning

Role of the Planning Section

12. There are two aspects of planning: long-term programming by senior officers, which we discuss in connection with allocating resources (Chapter 5), and short-term operational planning. The latter involves planning the work of individual gangs and relating to it the use of large items of plant and the supply of materials and contractors' services. Adjustments are required as programmes fall behind or get ahead of schedule. In many authorities planning is not regarded as a skilled function, is carried out by staff with no specific training and is therefore done badly.

13. Short-term planning is a specialist function which should be carried out by a separate unit. Our studies have convinced us that a small, specifically trained work planning section is of great value in any authority. Poor planning results

in gangs too large for the job in hand and in men waiting for work and lacking the necessary materials or plant. A work planning section can programme work across divisional boundaries and be responsible for taking into account the intentions of statutory undertakers. The section should have the advice of a trained mechanical engineer to advise on the suitability and availability of types of plant for particular jobs. This plant manager should also be responsible for programming the usage of the authority's large plant, all of which should be centrally controlled, and for ensuring that plant, whether owned or hired, is on site at the right time. The planning section should work in parallel with the foremen, who would however remain responsible for deciding how jobs are to be done, seeing that they are done satisfactorily and passing the gangs on to their next job.

14. Good forward planning is essential for any authority operating or proposing to operate a work study scheme; without it no scheme will realise its full potential for increasing productivity. We RECOMMEND that:—

a. every authority should have a work planning section supported by a plant manager;
b. all large or expensive items of plant should be centrally controlled so that their usage may be programmed by the plant manager in accordance with the works plan.

Centralisation and Co-operation between Authorities

15. The existence of a work planning section should lead to increased centralisation of the maintenance operation where this leads to improved efficiency. In some cases, such as resurfacing or surface dressing, central planning of all work, including any to be done by contractors, could lead to direct economies. The unit cost of surface dressing is higher when work is carried out in small sections; where road lengths needing treatment in different divisions are contiguous, central work planners can achieve economies by ensuring that the jobs are combined. Similarly if authorities offer contractors a more rational pattern of work, there should be scope for obtaining reduced prices. We RECOMMEND that the responsibilities of the work planning section should cover the programming of all resurfacing and surface dressing work, whether to be done by direct labour or contract.

16. Yet further economies could be achieved if adjoining authorities co-ordinated their resurfacing and surface dressing programmes. This would be particularly true so long as small highway authorities are found within counties and, pending any changes in local government organisation and functions, we RECOMMEND county councils and the local highway authorities within their areas to co-ordinate their programmes as far as possible.

Planning Routines

17. The main need is for the commonsense application of simple routines rather than the use of complex network programmes which, though they may be useful in some cases, are unlikely to be generally applicable. Authorities

should make far greater use of simple planning charts since it is a great help if programmes are presented graphically. We attach at Appendix 6 two examples of bar charts in actual use. In practice authorities often overlook the most basic planning routines. They are:—

a. estimating in advance the amounts of material, labour and plant required;
b. comparing the total 'load' with the annual resources available;
c. taking action in good time if the workload and the resources are incompatible, either by amending the programme or by making more resources available;
d. making short-term plans in the light of these modifications;
e. watching progress against the modified plans and initiating action to correct deviations as they appear.

Relations With Contractors and Suppliers

Use of Direct Labour or Contract

18. Decisions on the amount of maintenance work to be done by direct labour have various bases, of which cost is currently the decisive factor in only about a quarter of the cases. For the remainder the availability of labour with the necessary skills seems to be decisive, although tradition and geography often play an important part and also, but to a lesser extent, the Council's attitude to direct labour. We could obtain few data with which to make direct comparisons of the costs of work done by direct labour and contract and could therefore draw no conclusions on the relative merits of the two methods. We suggest that authorities should budget for a direct labour force sufficient only to carry out the estimated base work load. Peaks should be covered by employing contractors.

19. In comparing for individual jobs the costs of employing contractors with those of using their own men or plant, authorities tend to overlook relevant points. Examples are the need to make realistic apportionments of overheads to direct labour jobs and the need to allow for the administrative costs of placing and supervising an outside contract. Authorities should be more cost-conscious in their decisions about the use of contractors, both on trunk roads as agents and on the roads for which they are highway authority. Appendix 3 includes examples of the type of calculations authorities should make when considering whether or not to use contractors' labour or plant. The data for these calculations would be readily available in authorities exercising adequate control over the maintenance operation as set out in the following chapter.

Effect of Forward Programming on Contracting Arrangements

20. When authorities put work out to contract they often fail to allow for small changes in timing or other features which, though of little consequence to themselves, may significantly reduce the contractor's costs, enabling him to quote a lower price. The introduction of forward planning should enable authorities to place orders for delivery of materials several weeks in advance; suppliers would not then need to allow for large orders at very short notice. Our recommendations on central work planning and increased co-operation between authorities are

relevant to this point. Long-term contracts should also be considered. Some contractors are prepared to offer a fixed price for the benefit of a long-term contract; we were told that such contracts and adjustments in the supply pattern of some authorities could reduce rates by about 10%. We RECOMMEND all authorities to review regularly the possibility of reorganising their work in order to take the fullest advantage of market conditions.

Bulk Buying

21. Similar considerations apply to bulk buying. Annual tenders are in general use for most materials. However the considerable differences in the way in which contracts are operated reveal insufficient appreciation of the effect of purchasing power. There are authorities for example which divide the annual work or supply tender among several contractors. This should be done only if there are sound economic reasons. Some authorities merely make the *county tender* available to all claiming and delegated authorities so that all may benefit from the reduced price obtained from the county's large order, while in others constituent local authorities are obliged to adopt the county tender or pay the extra themselves.

22. We RECOMMEND that:—

a. county authorities should, if they are to gain the maximum benefit, include the needs of their constituent authorities in the quantities on which the annual tender is based;
b. authorities should order materials in bulk whenever possible, if necessary co-operating with their neighbours.

Tendering for Maintenance: Small Jobs

23. For the great majority of maintenance jobs, costing less than £1,000, it is unnecessary to go through the formal tender procedure. Alternative procedures should however be carefully defined though over-administration on minor items must be avoided. Small maintenance operations to be let out to contract can best be done by local firms. We RECOMMEND either a schedule of rates or individual quotations as the means of selection:—

a. *Schedule of rates*
The annual tender, (particularly for works), is often issued as a detailed schedule of rates for a wide variety of different maintenance operations such as kerbing, drainage or footway repairs. Following examination of a selection of schedules urban authorities will generally make a contract with a single firm for the year's work. In counties, where the firms' distance from a site can be an important factor in their price, the authority can calculate from the schedules, for each job as it arises, which of the approved tenderers will be the cheapest given the location of the work. Although the schedule of rates approach does not necessarily achieve the cheapest possible rates for the jobs concerned, it should bring savings in administrative costs which more than compensate for marginally higher prices. The schedule can be used not only for individual small jobs but also for a combination of jobs which

might in total cost up to about £5,000. The system can readily be computerised to compare selection and is then very easy to operate.

b. *Quotations*
Some jobs will arise which do not fit the schedule of rates and for others, eg emergency work, the schedule of rates contractor will not be equipped. In this case competitive quotations can be obtained from an approved list of local firms.
Lump sum quotations may also be an alternative to the schedule of rates where the authority seeks quotations from small firms annually and contracts with the cheapest for the year's work.

Tendering for Maintenance: Large Jobs

24. Formal contract procedures should be employed only for jobs costing over £5,000. These will not be frequent in maintenance except for such operations as resurfacing. When they do occur, selective tendering should be the standard procedure. We endorse the support of this approach given in the Banwell Committee's[5] and subsequent reports and commend as particularly useful to authorities "Selective Tendering for Local Authorities" produced by the Ministry of Public Building and Works as the second of their R & D Management Handbooks.

25. The following RECOMMENDATIONS on tendering cover detailed points which arose during our enquiry:—

a. Specifications need only refer to standard publications such as Ministry of Transport specifications, Institution of Civil Engineers' Conditions of Contract, Road Research Laboratory Notes and British Standards. Quotation in full adds to an authority's costs and is a waste of time to the tenderer.
b. Results of tenders should be released within three weeks of the closing date.
c. There should be further standardisation of tender forms.

Cost of Administration

26. Many of our recommendations on administration in this and other chapters may create the need for additional staff. We believe that the increased expenditure should be regarded as amply justified. The consultants suggest that by better administration alone the net savings available to authorities could amount to between 5 and 10% of total maintenance expenditure, in other words about £12m. We are not in a position to check this figure but the wide range of practice between authorities suggests to us that it is by no means unrealistic. The savings will come from many sources such as:—

a. greater gang flexibility, with increased productivity;
b. thorough control of usage of materials;
c. maximum usage of plant by central planning;
d. plant replacement at the optimum time;
e. planned maintenance of plant rather than expensive breakdown repairs.

27. The varying efficiency of authorities means of course that some have little scope for further saving while others should expect to save far more than our estimate. Savings will provide authorities with the option of undertaking more work or spending less money. The authorities with the lowest percentage of administrative overhead are not always the most efficient nor are they necessarily giving the best value for money. Indeed there is evidence that insufficient administrative backing is a direct cause of poor organisation and ineffectual control in several authorities. We therefore RECOMMEND authorities not to be deterred from adopting desirable changes in procedure merely because they may involve an increase in administrative staff.

Chapter 9: Control of Work

Present Situation

1. Although maintenance management will be improved by better organisation of the work and more rational allocation of the budget, these alone will not ensure that the money is spent in the way intended or in the most economical manner. For this there must be a constant comparison of input and output against the expectations or budget.

2. The traditional methods of accountancy of local authorities measure only money spent and compare it with intentions. Periodic progress reports on maintenance expenditure tend to concentrate on the class of road and the function on which money was spent. They do not measure the amount of work done for a given sum of money. Authorities are rarely equipped to identify with certainty the reasons for discrepancies between estimates and results and generally fail to allocate responsibility for them to the person(s) concerned, eg a supervisor or gang. Only a few of the more progressive authorities are adopting costing techniques designed to measure the results of expenditure; our investigators found many senior officers unfamiliar with this concept.

Objectives of a Control System

3. An effective control system should provide full information for the planning of future requirements of labour, materials, plant and contractors' services. It should then provide information about the achievement of the plan and deviations from it to each level of management in accordance with their powers to take remedial action. Good control systems become effective only if they are sufficiently dynamic to allow for changes in the base plan where necessary and if managers respond promptly to deviations from the expected results.

Present Position: How to Improve It

Control of Labour

4. Many highway authorities have not yet installed any form of work study or incentive bonus scheme. They therefore lack the data to control effectively the use of their labour force. Among authorities which have installed such schemes and have the necessary data, few use them except as the basis of bonus payments. Every authority should have a labour control system which relates output to manhours and should use it to assess the level of productivity achieved. We RECOMMEND that work study data should be produced in a form primarily suited to management control. Appendix 5 suggests one such form.

5. We have already discussed at some length the factors which affect productivity and how it may be improved. In this context we would merely repeat that improved productivity on the ground is largely a function of efficient management. Local authorities are slow to recognise that the effective running of a highway maintenance force requires substantial management skills in addition to expertise in civil engineering.

Control of Materials

6. In the authorities visited by our consultants the cost of road materials is the largest single component, 38%, of counties' maintenance expenditure and accounts for 20% of that of urban authorities. In spite of this, only half the counties and one-third of the urban authorities are exercising any control over materials usage. Such checks as they make generally lack any base estimate of usage with which to compare results and are confined to a few 'material intensive' operations such as resurfacing.

7. Proper control of materials, covering both usage and quality testing, should be introduced by all authorities. Control over the quality of materials can be carried out either in authorities' own laboratories or by private firms. Full control of materials usage is covered in the system put forward in Appendix 5. Relatively simple steps to improve materials control could lead to considerable savings.

Control of Plant

8. Expenditure on plant (in which we here include vehicles) and its operation represents between 10% and 25% of total maintenance expenditure incurred by the sample local authorities visited by our consultants. This proportion is sufficient in itself to justify careful control of plant purchase and usage but the consultants found many weaknesses in present practice contributing to excessive plant costs in some authorities. There are wide disparities:—

a. in the level of utilisation of plant. Plant use records do not always make clear for how much of the time plant spends on site it is actually in use.
b. in the periods for which plant is kept. Formal evaluation procedures for determining plant replacement policy are insufficiently used.
c. in methods of charging. Some authorities write off the whole cost of a piece of plant against a single job.
d. in hiring policies. Some authorities hire excessively on a long-term basis; too few determine their hire-or-buy policies on an economic basis.

9. All authorities should establish accurate records of plant usage and its running and repair costs. These records are essential if authorities are to use their plant to the maximum; they are also the only base for determining rational policies for plant buying or hiring or plant replacement. We include in Appendix 5 guidance on how the idle time of plant both in depot and on jobs can best be minimised and the types of cost records which should be produced. In neither large nor small authorities is there much evidence of the use of the discounting technique. Appendix 3 provides examples of how discounting may be applied to

cost data in decisions on hiring or buying plant and plant replacement. We RECOMMEND authorities to pay careful attention to their plant policies in the ways set out in Appendices 3 and 5 of this report.

10. Plant control is supplementary to the skilled choice of the most appropriate type of plant, and careful planning and direction of it on the job. For both selection and programming of plant authorities should employ qualified plant managers (see Chapter 8).

Suggested Control System

11. Appendix 5 outlines the type of control system required if authorities are to achieve the objectives we have discussed. It includes suggestions as to the type of progress report forms which authorities might find helpful. These are intended to be illustrative and should be adapted to particular needs. The prime control documents prepared by the roadmen, clerks and other highway department workers are extremely important. Their design should make very clear how they are to be completed. The management control system is dependent on accuracy at this level. Although not advocating the use of identical forms by all authorities, we believe that the scope for inter-authority comparison would be greatly increased if the control systems employed by all highway authorities expressed their results in common terms. The suggestions for standardised data put forward in Chapter 11 should help here. Appendix 5 also suggests how control reports might be distributed. Authorities need to give careful thought to this distribution; officers should see only information on activities within their control.

12. A control system implies a base against which to measure achievement. Those authorities without an incentive scheme or other detailed management data from which to devise such a base can use standard time values of the kind in Appendix 4 for this purpose. The planned maintenance programme can be converted from engineering units into standard time units. The planners, having measured Effective Performance, will then be able to assess the labour requirements and to construct a work programme with target starting and finishing dates for each job. They will also be able to estimate the need for contractors' services and the quantities of plant and materials required at particular times. These estimates will form the basis against which performance may be judged.

Control by Costs and by Resources

Financial Control

13. In our view one of the most important features of a control system is that it should supply information to staff at different grades in terms which they will find easily understandable. Management control is usually exercised only in money terms, since these provide a common form in which to describe resource use or output of widely different commodities. Financial control is often based on

standard unit costs for each activity, the cost of carrying out measurable units of the activity in an efficient way. The standard unit cost is compared with actual unit costs to indicate inefficiencies. Some authorities already use this method which is well-proven and can be developed in each authority according to methods of work.

14. There are however limitations in its use as the basis of maintenance control. First, an authority will need to be sure that the methods on which the unit cost is based are not only the best which can be achieved but also widely accepted as most suitable for the job. Second, the standard unit cost will include the cost of labour, plant and materials. Which of the three is responsible for any deviation between the standard and the actual unit cost will not be apparent. Thus although unit costs could be valuable in inter-authority comparisons, we have concluded that, used for control within authorities, they could lead to the perpetuation of bad practice by concealing it.

Resources Control

15. We have therefore considered the possibility of basing control primarily on the use of resources, with most control reports entirely in non-financial terms, which would certainly be more easily understood by middle and lower management. Control would consist of comparing standard units of each input, (labour, plant and so on), estimated for each job, with the resources actually used. If these estimates are based on methods justified by work study, efficient purchasing arrangements and correct use of plant, this system would effectively control costs too. Unit costs for operational control purposes would thus be unnecessary, but the system we have in mind permits their extraction without difficulty should they be required for other reasons.

Comments

16. We have seen that Cambridge City Council who operate such a system, described in Appendix 5, can exercise thorough control over all the activities covered by highway maintenance. As with all systems of control it requires a rapid feedback of information about actual performance to the officers concerned so that prompt action may be taken if discrepancies arise. The system also depends on the reliability of the performance standards used as the measure of labour efficiency; only authorities which had undertaken method studies and work measurement could be sure that their standard units were really appropriate.

17. We have concluded that the non-financial method of control is not only practicable but may be preferable for the control of highway maintenance since employees will find it easier to operate and understand. We suggest that Chief Officers and senior managers should receive both financial and non-financial reports but that lower management should receive only those in non-financial terms. We RECOMMEND authorities to introduce a control system on these lines.

Computers for Control

18. Computers are increasingly used in local government. We therefore offer some suggestions about their application to highway maintenance control:—

a. When introducing a computerised system, authorities should always reconsider from first principles what data they need for effective control. Computers provide the opportunity for handling more data more quickly than before. A professional systems analysis should be undertaken at the outset, since simple transfer of existing practice on to a computer will not make adequate use of the computer's potential unless the system itself is sound.

b. Where authorities already use computers for the production of control data, the few significant items tend to be obscured by the sheer volume of information printed out. One of the computer's main attractions is its capacity to print out, in any form required, only the essentials while storing the rest. Authorities should use exception reporting so that print-outs will produce only data requiring management action, eg deviations of more than a specified percentage from estimates.

c. Control information is needed quickly. In 30% of the counties and 60% of the urban authorities visited, control information produced by computer is not available for over three weeks. In such cases control figures are therefore often also produced manually. Authorities should make greater efforts to release control data quickly to the officers concerned; all benefits are lost unless the information is available within a few days.

d. Programming faults are inevitable when a system is first installed. They should be expected and remedied at the earliest opportunity.

e. Highway departments should have their own computer-trained staff working in close liaison with the authority's central computer group. Closer co-operation is often required between highway and treasurers' departments to ensure that the former get precisely the data they need and that they get them at a time when they are still useful.

19. The administration of highway maintenance should improve further with the introduction of standardised computer output in local authorities. We welcome the efforts LAMSAC is currently devoting to standardisation and suggest that authorities should make full use of that Committee's advisory service on computers.

Chapter 10: Trunk Road Maintenance Control

Present Position

1. In England the Minister of Transport is the highway authority for trunk roads, which include nearly all motorways, and as such is responsible for their maintenance. The Secretaries of State in Scotland and Wales are similarly responsible for trunk roads in those two countries. In this chapter we discuss trunk road maintenance primarily by reference to practice in England, where the Ministry of Transport is represented in the provinces by Divisional Road Engineers (DREs). Both Scotland and Wales are administered as single areas whose trunk roads are controlled from headquarters by a Chief Road Engineer. However our comments on the methods of management and data collection generally apply to all three.

2. Since none of the departments has a direct labour force, they appoint local highway authorities as their agents to carry out the maintenance work. Many of the management control points set out in earlier chapters would thus automatically be applied to trunk roads if they were adopted by local highway authorities and, of course, accepted in principle by the three departments.

3. There would be early dividends from going ahead as soon as possible with the introduction of our proposed revised methods—of fund allocation, of selecting priorities and of uniform standards—on trunk roads. This should be a simultaneous development with their introduction by local highway authorities on other roads. We regard progress on trunk roads as particularly important however since the centralised responsibility for these means that there would be a rapid feedback to the three central departments concerned on the effects or inadequacies of the new methods. This information could be easily made available to all local highway authorities. A further advantage would be that changes in trunk road maintenance would affect a considerable number of local highway authorities which would thus be conveniently and effectively introduced to the new, uniform methods. Since they currently administer the maintenance of their own roads in the same way as that of trunk roads, the introduction of new methods on the latter would be an incentive to apply them throughout to avoid two different systems. We RECOMMEND that the proposed initial standards and methods of fund allocation and of selecting priorities be introduced on trunk roads as soon as possible.

Agent Authorities

4. A major obstacle to a more rational organisation of trunk road maintenance, both of work and data, is the large number of agent authorities. These

comprise 70 county and county borough councils and 125 borough and urban district councils in England, and totals of almost 20 in Wales and over 30 in Scotland. Some are responsible for no more than one or two miles of road. This arrangement has its roots in history and is not in line with the interests of overall national efficiency. The time has come to reduce the number of agents to take advantage of the benefits of modern management techniques. No hard and fast criteria should govern the appointment of local highway authorities to maintain trunk roads; circumstances which justify this will vary. But delegation to authorities other than county or county borough councils should in present circumstances be exceptional, and the departments should aim greatly to reduce the number of agent authorities by withdrawing appointments from those managing only small mileages of trunk road. This step may arouse protests but we believe it is essential to improve trunk road management. Although it will obviously be some time before the changes in local government following the Redcliffe-Maud[2] and Wheatley[13] Reports are introduced the action proposed here would be consistent with the recommendations in those reports besides being justified in its own right. We RECOMMEND that the departments should therefore terminate all agency appointments relating to uneconomic mileages of trunk road.

5. The relationship between the government departments and the agent authorities is based on a statutory delegation of functions, set out in agency agreements. But, given the nature of the bodies involved, these agreements cannot be regarded as comparable to commercial contracts having a final remedy in the courts. Thus even if there were improved criteria for investigating excess expenditure and standards by which to judge value for money, the departments would have to depend more on the goodwill and sense of responsibility of the agent authorities than on a revised form of agreement to achieve improvement in performance where this could be seen to be needed. However if the number of agent authorities is greatly reduced as we propose, the problem of appraising efficiency will be diminished.

6. We suggest that the Ministry should in this context give further thought to its relations with agent authorities. The present indeterminate policy governing the relationship between the Ministry, represented by the DRE, and the agent authority needs to be replaced by something more positive. Many agent authorities see themselves as the planning and controlling organisation for the maintenance of 'their' trunk roads while at the same time DREs are expected (in the absence of any more specific rule) to have a degree of control over detail which is neither possible nor efficient. This leads to duplication and wasted effort. The Ministry should instead explicitly provide for the DRE to exercise only overall policy and financial control on the basis of full information supplied by the agent authority and for the latter to carry out the work free from detailed, day-to-day supervision.

Allocation of Trunk Road Funds

7. If the three government departments with centralised responsibility for trunk roads are to play a leading role in improved maintenance management, their methods need as much urgent revision as those of local highway authorities. In order to put our recommendations for change into perspective we set out briefly in the following two paragraphs the processes which apply in England.

Present Procedure

8. The agent authorities assess the maintenance needs of the trunk roads in their area. Financial estimates for the following year are sent to DREs in June, together with figures showing how much the agent was allocated and actually spent in the previous year and their estimated expenditure in the current year. These estimates, adjusted if considered necessary by the DREs, are sent to Ministry headquarters by the end of July. DREs are informed as soon as possible what the allocation to their division is likely to be so that they may decide and tell agent authorities their provisional allocations. A modest reserve will have been retained by the Ministry for unforeseen works and emergencies.

9. Once the agent authorities know their provisional allocation, they compile a detailed maintenance programme for each trunk road. These proposals are then submitted to the DREs who have been in close contact with the agent authority throughout the year and are therefore unlikely to suggest any radical changes. The DREs are generally able to notify the agent authority by March of their firm allocation for trunk roads.

Conclusions

10. When in June DREs have to assess the estimates of proposed total expenditure on each trunk road by each agent, they are not equipped to make such an assessment. They do not yet know precisely what work is proposed and their only quantitative guide, apart from intimate knowledge of the roads concerned, is the breakdown of the authority's past expenditure. Even this may be of little help, since the general maintenance heading on the expenditure returns in some cases accounts for more than 50% of expenditure. When the Ministry decides on the total funds to be made available for trunk road maintenance, it has even less information on which to base its view. It can choose only between ensuring a standard distribution of funds per mile of road or basing the allocation on that of previous years, taking into account specific operations known to be necessary and information received from the DREs on the state of trunk roads, and making sure that no particular division is given an amount vastly in excess of its last allocation. Neither approach can lead to a rational allocation of funds, and there has so far been no means of assessing the maintenance needs of different areas in a quantified and comparable manner. The annual compilation of a 'reasonable' bid for trunk road maintenance funds is therefore an arbitrary process.

11. The estimates of financial need made in June are arbitrary because they are compiled without the help of the detailed works programmes which are prepared later, after the national bid for funds has been made and the provisional alloca-

tion notified to agents. DREs usually receive detailed programmes too late in the year to permit radical changes to the provisional allocations already notified. In view of the relatively broad-brush manner in which total maintenance funds are determined, we see no reason why the firm allocations are notified to agent authorities at such a late stage, sometimes after March. Earlier notification is essential if they are to programme their maintenance including that of trunk roads, on the lines we have proposed (Chapter 8: Organisation and Administration). We RECOMMEND that the Ministry should notify agents of their firm allocation considerably before the beginning of the financial year to which it applies.

12. Although each detailed maintenance programme is the result of a continuous dialogue between the agent authority and the DRE, who would therefore probably agree it in principle, we would prefer to see DREs allocating funds on a more uniform, quantified basis. DREs are free to change the proposed expenditure for individual jobs but they can judge the reasonableness of the estimate only by reference to estimates for similar work from other agents in their division. Data are not at present collected in a way which would permit expenditure to be related to standard costs and too little effort has been made to compensate for this, for example by giving DREs specific guidance on the criteria by which they should judge agent authorities' estimates. Our recommendations in para 17 on changes to the Ministry's present data returns include some designed to enable DREs to check for consistency the standards applied as well as the estimated costs.

13. Management of the trunk road maintenance programme has not so far been developed so as to permit the selection of priorities to be made across the whole country. However this position is changing as far as jobs costing over £50,000 are concerned; these are now examined in Ministry headquarters to ensure that available resources are used in accordance with an assessment of national priorities. This is certainly a step in the right direction but far more will need to be done, for example in defining maintenance needs, if all trunk road funds are to be allocated on a meaningful system of priorities.

Data Returns

14. The returns provided by the Ministry for completion by agent authorities at various dates through the year could be improved to give DREs more help when considering allocations to individual agents. In the previous chapter (Control of Work) we emphasised the limitations of actual unit costs as an internal management tool. However estimated unit costs could be a valuable aid in inter-authority comparison and all authorities could reasonably be requested to supply them to DREs. This they should do when submitting their financial estimate for the following year so that DREs may more readily identify and query excessive rates for particular operations.

15. Agent authorities indicate on the detailed programme return which materials they intend to use for resurfacing and surface dressing and, where

appropriate, the construction depth. We believe DREs would be able to form a clearer view, for purposes of inter-authority comparison, if they also knew the area of road to be treated and the relevant materials specifications.

16. Two general problems arise from the design of the present data returns. The first is that the programme returns for all-purpose trunk roads require more details than those for trunk road motorways. This inconsistency prevents the compilation of a uniform set of data on the maximum mileage of road. The other problem encountered in analysing trunk road data as collected on the existing forms is that the lengths of road to which the expenditure figures relate are simply those for which individual agents happen to be responsible. Data on traffic flows are collected on a different basis and it is not possible to relate the two for purposes of management control. The central data unit proposed in the next chapter will need an improved set of figures if the relative effect on expenditure of the many variables affecting maintenance is to be assessed.

17. Following are our RECOMMENDATIONS on data returns:—

a. Agent authorities should, at the provisional estimate stage, supply DREs with their estimated unit cost for each operation.
b. Programme details should include, for resurfacing and surface dressing, the area of road to be treated and the relevant materials specification.
c. Programme returns should collect data under the same headings for motorways and all-purpose trunk roads.

Planning of Trunk Road Maintenance

18. There are three main steps in maintenance planning:—

a. annual selection and forward planning of work to determine which projects should be carried out in the forthcoming year and which may most economically be postponed;
b. more detailed programming of the timing of individual, usually the larger, jobs and ensuring that necessary plant, labour, contractors' services and so on are available when required;
c. day-to-day progressing of jobs against the programme and dealing with any deviations.

In our view DREs should play a more positive role in (a) than is sometimes possible at present and should also occasionally be consulted on the first part of (b), for example if summer work has unavoidably to be undertaken on a holiday route and could give rise to adverse reaction. This is not to imply any duplication of agents' work by DREs with the increase in their staff which this would entail. But the provision by agents of more relevant information in the June estimates would at least put DREs in a better position to ask the right questions. Constant contact between DREs and agent authorities will still of course be of prime importance but the additional data should enable the proposals of different agents to be assessed on a more uniform basis. The responsibility for the remainder of (b) and for (c) should be placed entirely on the agent authority.

19. We discussed in Chapter 5 (Allocation) our view that there is scope for a great increase in long-term planning of maintenance. Although Exchequer funds are voted annually by Parliament and cannot be carried over from one year to the next, this does not necessarily inhibit a longer-term programme such as we have suggested for local highway authorities. For example DREs are told three or four years in advance what funds are likely to be allotted to their divisions for small improvement schemes on trunk roads; the practice could as easily be applied to maintenance.

20. The annual accounting system does, however, have constraining effects on those who operate a programme and the fear of 'losing' resources and the reluctance to plan for more than the period those resources cover gives rise to lumpiness in the way in which functions are carried out. It is therefore important that those concerned should be fully aware of the best methods of controlling a continuous programme in an annual accounting setting. The Ministry attempted some years ago to run maintenance and minor improvements on the basis of a ten year programme. This failed almost immediately through inadequate planning and because far too many miles of trunk road were omitted from the maintenance programme on the mistaken assumption that their needs would be covered within the 10 year period by the major improvement programme. No further efforts to plan maintenance over a long time span have been made. We RECOMMEND:—

a. that the Ministry should institute a firm three year maintenance programme for trunk roads based on a long-term improvement programme;
b. that the Ministry should notify DREs of the funds likely to be available for at least three years ahead, so that agent authorities can plan trunk road maintenance over the same time span as maintenance of their own roads.

Control of Trunk Road Maintenance Programme

21. The constraints of public accountability have ensured that the financial control of actual expenditure is efficient and accurate. A record is kept of all commitments and a monthly statement of these is produced. Control of the trunk road maintenance programme is conducted entirely in terms of these expenditure flows and none of the returns made to the Ministry shows whether the programmes on which the allocation of funds was based have been carried out. Thus, while accounting control is suitably strict, it is not supported by any cost or management control of the kind discussed earlier. We have concluded that the Ministry seems to make little attempt to take action on the basis of the few facts which do emerge from available returns, such as the great difference between agent authorities' expenditure per mile. The need for such action is evident. The RRL have established that it is not only the amount of expenditure on trunk road maintenance which varies so much, it is also the pattern of this expenditure, and as we shall show in the next chapter (Data) these variations cannot be satisfactorily explained by local differences in climate, topography or traffic.

22. We believe that DREs should be in a position to see if and how efficiently the programme is being carried out. In future therefore agent authorities should be asked to submit periodic progress and programming reports: the present returns which go under this name are simply estimates of expenditure in the following year. The new reports should relate expenditure incurred to work done or in hand, using the same headings as the detailed proposed works form so that achievement may be compared with the estimate. If such a return were made, say, quarterly it could enable the DRE, in cases where overspending seems likely, to contribute to the decision as to which of the outstanding jobs programmed for the year could most economically be postponed. We RECOMMEND that the departments should arrange for agent authorities to complete a new return on the lines proposed.

23. Estimated unit costs will be more useful when DREs know the maintenance standards to which they relate. The departments should therefore ensure adoption of the initial standards on trunk roads by the time agents are asked to supply their unit costs. When unit costs are more widely used to establish comparability and when expenditure is related to work estimates and work done, the departments' control of trunk road maintenance could achieve the following objectives:—

a. even out standards and expenditure in relation to vehicle usage and other known variables between agent authorities;
b. identify the causes of over-expenditure;
c. operate trunk road maintenance as a single programme rather than as a large number of programmes.

As we have already said, a control system is only of value if action follows analysis of the data presented. We therefore RECOMMEND that the departments should develop the necessary managerial and engineering organisation to ensure that control of trunk road maintenance is exercised so as to achieve the objectives above.

Chapter 11: Consideration of Available and Required Data

Available Expenditure Data

Published

1. Information on national maintenance expenditure is published annually by the Ministry of Transport in the 'Roads Report' and 'Highway Statistics' and, for counties, jointly by the Society of County Treasurers and the County Surveyors' Society in the report 'Highways Expenditure'. None of the published documents breaks down maintenance expenditure into its component parts but all show expenditure according to class of road. The Ministry's 'Roads Report' provides only figures of total expenditure. 'Highway Statistics' gives two totals, one for snow clearing, cleansing, watering and administration and another for remaining maintenance functions. It also provides figures for maintenance expenditure by individual counties and county boroughs according to road classification. 'Highways Expenditure' also gives maintenance expenditure by each county by class of road.

Unpublished

2. For each trunk road the Ministry of Transport, the Scottish Office and the Welsh Office keep, but do not publish, an analysis of maintenance expenditure under 6–8 heads by type of work. Local authorities also keep more detailed data on their maintenance expenditure than those which are published. Some break the expenditure down into 20 or more functional groups.

Inadequacies of Available Data

Trunk Roads

3. The data, published and unpublished, on trunk road maintenance expenditure are inadequate because:—

a. Different headings are used for motorways and other trunk roads.
b. The functional breakdown is not sufficiently detailed.
c. The Ministry does not insist on all the headings being used.
d. Interpretation is made more difficult by the inclusion of the heading 'general maintenance' without definition of its scope.
e. Expenditure data are collected for the stretches of road which happen to be maintained by each agent authority and which differ from those for which data on traffic flow, road width, structure and so on are available. Thus the two cannot always be correlated.

Local Authority Roads

4. Local authorities analyse highway maintenance expenditure under headings of their own devising. Some keep detailed records; others make little breakdown. Meaningful comparisons of expenditure between authorities cannot therefore be made. Local records are also defective statistically in a more general sense. For example authorities tend not to have adequate information about traffic flows, so making impossible one most useful form of comparative analysis.

Our Attempts to Supplement and Interpret the Data

Trunk Roads

5. Data for trunk road maintenance expenditure are collected in a uniform manner from all agent authorities (notwithstanding the deficiencies mentioned in para 3) and seemed to offer the best opportunity for comparative analysis. In addition therefore to the RRL study of all maintenance data (see paras 8–11 below), Ministry of Transport economists attempted to identify the factors which cause the wide variations—from less than £800 per mile per annum to over £5,500 in counties and from £2,240 to £4,050 in urban areas—in expenditure on trunk roads between agent authorities.

6. The available data were analysed in detail using several different approaches. Whatever approach was adopted, no more than 50% of the variation between agents' expenditure could be explained by objective factors, the most important of which seemed to be the weather, traffic flow and road widths. The analysis suggests that there is a trend in expenditure amounting to a fixed increase each year, which is in line with our conclusions on the traditional allocation of trunk road funds (see Chapter 10). It also suggests that there is a threshold level below which maintenance expenditure is unlikely to fall, however low the traffic flow. The conflicting conclusions reached from analysis of data from different years may be further evidence of inconsistent patterns of spending.

7. The conclusions outlined above must however remain tentative. The most definite conclusion the analysis allows us to draw is that the available basic data are inadequate and do not cover factors such as subsoil or type of construction. Since they are the basis for important expenditure decisions, data on trunk road maintenance expenditure and other relevant factors should be collected in a form and in sufficient detail to permit more rigorous analysis. We believe this change is imperative if real value is to be obtained from the expenditure data, the continued collection of which can hardly be justified in its present form. We RECOMMEND that the departments should consider urgently how they may collect, for the same lengths of trunk road, data covering details of traffic flows, road geometry and maintenance expenditure under the proposed standard headings.

Local Authority Roads

8. The Road Research Laboratory analysed highway authorities' maintenance expenditure but had difficulty in putting the data from the 22 authorities

into categories which made useful comparisons possible. Differences in accounting heads prevented separate study of each of the selected maintenance functions (see Chapter 2). Instead the RRL attempted analysis based on 13 heads but the wide ranges in expenditure in these heads for similar classes of road led them eventually to resort the functions into only three broad groups: structural, aids to movement and safety, and amenity. Expenditure under general maintenance and miscellaneous heads had to be excluded from the analysis. A slightly more meaningful pattern emerged from this, but it was more helpful for the differences between classes of road than between authorities.

9. The RRL examined total maintenance expenditure in each of the 22 authorities in two forms for different classes of road: per mile of road per annum and per 1,000 vehicle-miles (cost-usage). In the absence of complete data on traffic flows for each authority, the RRL analysis of standards in relation to expenditure had to rely on figures for the 12 much larger areas into which the country is divided for the purpose of collecting national traffic data. There were naturally distortions when traffic flow figures from these larger areas were related to expenditure figures from much smaller areas.

10. Some conclusions could however be formed:—

a. On little used roads expenditure per mile is less than, but expenditure per vehicle mile more than, that on busier roads. See Figures 4 & 5, Appendix 7.
b. The cost per vehicle mile for Class III and unclassified roads is particularly high. This should be seen in its context: these roads comprise 75% of the total network, carry less than 30% of all traffic and account for 55% of total maintenance expenditure.
c. The range of cost-usage figures is smaller for urban than for rural roads, and the figures tend to be lower in urban areas than for rural roads of the same class.

11. Neither the annual-cost per mile of road method nor the cost-usage method of assessing expenditure alone enables useful comparisons to be made between different classes of road and roads in different authorities. Many other factors are involved, notably the state of the road structure, heavy vehicle flow which largely determines structural maintenance needs and total vehicle flow. The cost-usage method gives a better indication of value for money than cost per mile, though all the relevant factors, including cost per mile, should be borne in mind in interpreting the cost usage figures. We RECOMMEND that highway authorities should keep sufficient records of average annual traffic flows on all their roads, using sampling techniques wherever possible, to be able to determine reliably the average usage of the whole of their network, by the categories of road defined in Chapter 4.

Action Needed to Make Data More Useful

Standard Accounting Heads

12. Significant inter-authority comparisons cannot be made until authorities use standard heads of account and classify output according to the same units.

Having studied the existing breakdowns of trunk road maintenance expenditure, the current practices of local authorities and various suggestions made to us, we have devised standard accounting heads. We believe that they provide the minimum degree of detail needed to permit meaningful analysis. Close definition of each head will need to be worked out before uniformity between authorities can be achieved, though we have ourselves suggested how the 'administration' heading might be dealt with. Adoption of this set of accounting heads would bring a vast improvement over present data collection. Local authorities will no doubt elaborate them for internal use, but it is essential for national statistical purposes that accounts are kept rigorously in the standard form. We RECOMMEND that these heads of account should be adopted by all local authorities and also by the three central departments responsible for trunk roads and motorways:

1. Resurfacing and reconstruction.
2. Surface dressing.
3. Patching (and other minor *ad hoc* repairs).
4. Bridges, subways and other highway structures.
5. Embankments and cuttings (excluding grass cutting).
6. Grass and hedge cutting and siding.
7. Fences.
8. Kerbing, footways and cycletracks.
9. Road markings (to include reflector studs and pedestrian crossings).
10. Guard rails and safety fences (crash barriers).
11. Traffic signs, bollards, direction signs, traffic lights (to include motorway surveillance systems, telephones, warning signs and their lighting etc).
12. Street lighting.
13. Drainage (excluding gully emptying).
14. Gritting and salting (to include cost of under-road heating).
15. Snow clearing.
16. Sweeping, cleansing, watering and gully emptying.
17. Administration.*

13. We have not included a 'general maintenance' head which offers too easy an option, attracting an excessive proportion of total maintenance expenditure, over 60% in a few cases encountered in the RRL study. There should be no place for a general maintenance head in any system of standard accounting.

Improved Units of Output

14. We considered in para 11 above the advantages of traffic flow as a broad measure for comparing highway maintenance expenditure in different authorities

*This heading includes administrative expenses directly charged to highway maintenance, such as the cost of administrative, professional, technical and clerical staff of the highway department, plus an allocation made to highway maintenance of the central administrative expenses of the highway authority as a whole. Credits will normally be allowed under this heading for recharges to other accounts.

in terms of value for money. It remains to deal with expenditure on individual functions in terms of the output obtained for a given expenditure.

15. Details of expenditure unrelated to a measure of work done are of limited use, especially in comparative studies. For this reason units of output for maintenance functions, eg unit areas of paving relaid, number of gullies emptied, or unit lengths of kerb laid, are already used to some extent by individual local authorities as a means of assessing their own efficiency. But as with the classification of expenditure there is no uniformity of practice. There has been no systematic attempt to ascertain what are the most appropriate output units and their possibilities have not been fully exploited.

16. Recently however work study schemes have led to the production of valuable data related to output units. If these units could be standardised before work study on different bases is too widely established, we believe that work study data could become the major source of inter-authority comparison for highway maintenance. They would enable performance to be judged in relation to output and reasons for discrepancies between authorities to be explored. Some authorities already exchange such data for this purpose. We have not been able to consider this question in great depth but we believe that the units defined in Appendix 4 as the basis of the standard time values could serve as a useful starting point. We RECOMMEND the Ministry and local authority associations to co-operate in producing a standard list of maintenance outputs and to study the subject in conjunction with work study systems.

17. Uniform output units would make possible inter-authority cost and efficiency comparisons. There is no better proven yardstick for inter-authority comparison than unit costs though the cause of discrepancies may often be hard to identify. They can be employed most easily and effectively for trunk road maintenance in the first instance. Agent authorities could supply data on an agreed basis without difficulty if they introduced the control system we have advocated (Chapter 9). Lessons learned from the initial experience of using unit costs on trunk roads could be extended to other roads. The units on which they are based should be progressively refined so that the unit costs may eventually be related to the quality of the output produced.

Central Data Unit

18. If the improved maintenance data are to yield their full value, they should be the subject of continuing study and analysis. The data collected at present are wholly inadequate for such purposes. They are incomplete, inconsistent between authorities, and do not lend themselves to further analysis. They cannot support any but the most provisional conclusions; for example the large variations in the pattern of expenditure still defy explanation. In particular there is an urgent need for greatly improved data in order to quantify precisely the effects of external factors on maintenance expenditure. We recommended earlier that the Ministry should obtain further information about trunk roads and we suggest that all highway authorities should collect for their own roads data on

such factors as total traffic flow, heavy vehicle flow, subsoil and weather which seem relevant to levels of maintenance expenditure.

19. To serve the purpose outlined above the data should be supplied to a central data unit responsible for their analysis. A highway maintenance data unit of this kind could work for both central and local government, possibly as part of an organisation responsible for the collection of other highways data. Initially based on trunk road data, which are likely to be the first available, the unit's work should extend rapidly to analysis of maintenance data for all roads. The unit could make its results available to all highway authorities and later help individual authorities in handling statistical problems. We RECOMMEND that the three central government departments concerned and the local authority associations should co-operate to set up a central highway maintenance data unit.

20.The unit could also concern itself with questions such as long-term versus short-term maintenance and the relationship between the initial design and construction costs and subsequent maintenance, on which we have not been able to reach conclusions for lack of data. It might also be able to give guidance on a financial standard, in terms of an average expenditure on types of maintenance in different circumstances; this could complement the objective performance standards. The unit could also become the focal point for further study of output budgeting for maintenance since it will be the recipient of a major part of the data necessary for the exercise.

21. Our emphasis thoughout has inevitably been on the need for increased, comparable, more detailed data. There is however a danger that excessive data may be accumulated or requested from agent or local authorities. We assume that before each extension the new unit will make full use of modern techniques to assess the advantage of additional data accumulation.

Manpower Data

22. Finally we would add a footnote on the need for much improved manpower data to be collected nationally. If maintenance management and training is to be properly organised, the number of employees at the various levels, the recruitment trends, wastage rates, extent of training and other relevant information must be known. There are of course difficulties because those who are employed on maintenance often spend part of their time on other highway work. Nevertheless we consider the existing national employment statistics, which do not distinguish highway workers from other building and civil engineering workers, totally inadequate. We RECOMMEND that improved manpower statistics be collected for those employed on highway work, identifying by grade the numbers engaged on maintenance.

Chapter 12: Maintenance Authorities

Introduction

1. Most of our proposals could be implemented without changes in legislation. There are however some changes in the legal framework within which maintenance is carried out which could increase efficiency and help to improve recruitment.

Size of Authority

2. The consultants found that management effectiveness is significantly better in the larger authorities, (although some small authorities are of course well run by able and enthusiastic officers with good support from elected members), and that higher standards are particularly to be found in authorities of over 200,000 people. Salaries of chief officers are a reflection of the population of their authority and in smaller authorities salaries for middle management levels are correspondingly reduced. This offers some explanation of the consultants' conclusion that highway authorities with a population below 100,000 are on average noticeably less competent than their larger counterparts.

3. Many of the recommendations set out in our report, though not necessarily requiring large authorities for their implementation, do imply that some present highway authorities are too small. For example we suggest that staff complements ought always to be sufficiently large to allow for a proportion of staff to be absent for training courses and that supervisory staff should have formal qualifications. Our recommendations on methods of management control assume that every authority will either own or make use of a computer. We therefore believe that efficiency demands a minimum size for highway authorities.

4. Although statistical evidence about the relationship between the size and effectiveness of local authorities is negligible, we have come to the conclusion that efficiency in maintenance would best be achieved if the minimum size of authority were to be increased. Larger authorities can:—

a. pay their chief officers substantial salaries and therefore have room to offer an attractive career structure in maintenance at middle management levels;
b. make full use of the buying power and better management of materials available to the large-scale purchaser;
c. make best use of the limited supervisory skills at present available and of systematic training in management and foremanship;
d. take full advantage of the scope for economies of scale by the full use of the latest management techniques, and modern plant and equipment;

e. provide opportunities for the full employment of craftsmen with special skills;
f. provide a range of tasks where the use of labour would be kept flexible.

5. We believe that an authority with a population above 200,000 could operate an efficient highway maintenance organisation but that outside the areas with high population densities authorities below this preferred minimum may have to be accepted.

6. We note the views of the Committee on the Staffing of Local Government as set out in their report[1] (the Mallaby Report) and the recommendations of the Royal Commission on Local Government in England.[2] The Mallaby Report discusses the relationship between the size of an authority and its chances of recruiting well qualified officers, though it does not discuss specifically the appointment of qualified supervisory staff. It concludes that size is not a critical factor in the recruitment of the broad professional categories such as engineers but could affect more specialist advisers. The Royal Commission could not establish a statistical relation between size and efficiency but, on the basis of subjective appraisals of education and the children's services, found that in those specific fields authorities with a population of less than 200,000 appear likely to be the least efficient. For this and other reasons they have proposed the establishment of local authorities with populations falling between 250,000 and 1,000,000. We note especially their comment that highway departments in the larger counties and county boroughs are among the few where economies of scale seem to be operating.

Delegation of Maintenance Functions

7. We find that inefficiencies are often due to the right of a local authority of 20,000 population or above (see Table in Chapter 2, facing page 61) to *claim* the maintenance of the county roads in its area and of smaller authorities to have the maintenance of county roads *delegated* to them. We feel strongly that the practice of *claiming* and *delegating* for which provision is made in the Highways Act, 1959, should cease. This would be so if in future all highway authorities have populations of over 200,000, as we suggest. Claiming and delegation by law have also been rejected by the Royal Commission for Local Government in England.

8. Our conclusions, in the context of highway maintenance alone, are entirely in agreement with those of the Royal Commission. We have never been in any doubt that maximum efficiency can be achieved only if absolute control of maintenance work and determination of the standards to be adopted rests with the authority which bears the financial responsibility. The present statutory provisions governing claiming and delegating do not in practice afford the sort of control which we consider essential.

9. On the assumption that the Royal Commission's proposals would be implemented we considered the possibility of a limited group of maintenance functions being carried out on behalf of the larger authorities by local councils on an

agency basis. The functions which, because of their specifically local character, would be suitable for this arrangement (which we call 'assignment' in order to avoid confusion with terms used in the Highways Act) are however too limited to warrant a separate direct labour force and the attendant administrative organisation. Since we can see no advantage in efficiency in suggesting assignment to local councils of a fixed set of functions, we have rejected this functional approach. We have concluded that there should be no regular assignment of maintenance functions from unitary authorities to local councils.

10. We therefore RECOMMEND that:—

a. the proposed larger highway authorities should retain full responsibility for all aspects of highway maintenance in their areas;
b. legal rights of claiming and delegation should cease.

Suggested Changes in Powers of Highway Authorities

11. Our investigations have shown that certain miscellaneous changes in highway authorities' legal powers would enable them to carry out maintenance more efficiently.

Contributions to Cost of Road Damage

12. The use of weak roads by unsuitable heavy vehicles adds considerably to the cost of maintenance. In Section 62 of the Highways Act, 1959 (in Scotland, Section 54 of the Road Traffic Act, 1930) provision is made for the highway authority to recover from those responsible any 'extraordinary expenses' on the maintenance of roads which have been damaged by excessive weight or 'other extraordinary traffic' passing along them. This provision does not go far enough. It does not enable the highway authority to recover the cost of prior strengthening to avoid damage. Yet it would in almost every case be cheaper to strengthen a road in advance of its use by exceptional traffic than to repair damage already inflicted. The cost to both the persons concerned and the public would be reduced if advance claims could be made by the highway authority.

13. We understand that neither Section 62 nor its predecessors has been easy to interpret or to enforce and there may be difficulties in extending it. Nevertheless, if for example a new quarry is to be opened up at the end of a country lane or a new rail head for coal distribution over residential roads, the persons concerned ought before the beginning of operations to be liable for some contribution to the strengthening of the road. Under present law the highway authority would not be able to recover any of the expense of work done in advance in order to reduce the cost of later repairs, although this is sometimes done by agreement. Although planning powers may prevent development which would lead to road damage, planning permission cannot be made conditional on advance contributions being made to strengthening costs. We therefore RECOMMEND that further consideration should be given to the possibility of empowering highway authorities to secure advance contributions towards the cost of road strengthening in appropriate cases.

Traffic Regulation Orders

14. A further strain on maintenance resources is the use of minor roads by heavy traffic because they offer a short cut or are otherwise preferred by the driver. The number of vehicles of the maximum permitted axle weights can be expected to grow and it is therefore becoming increasingly important to limit their use on inadequate roads. It is uneconomical to maintain all roads in a state suited to all traffic. Each local highway authority should determine which roads form its basic network and maintain only those for 'through' use by heavy traffic.

15. The only power available to local authorities specifically to restrict the use of roads in the manner we have proposed is that which allows them to make traffic regulation orders. Use of this power is however limited if access would be affected. The main powers of traffic regulation are contained in the Road Traffic Regulation Act, 1967, as amended by the Transport Act, 1968. They are exercisable by the local authority, which in this case means the county council, the county borough council or the council of a non-county borough or urban district with a population of over 20,000. It is in general difficult to operate and enforce these powers but some authorities have successfully applied traffic regulation orders to several of their minor roads. We do not believe however that local enactments are the only way of tackling this problem. National legislation to control the movement of unsuitable vehicles on certain types of road by means of a general provision might be more satisfactory.

16. We RECOMMEND:—

a. that the Ministry of Transport should promote any changes in highway authorities' liability for non-feasance necessary to enable them to maintain only a specified network of roads in a state suited to all traffic;
b. that all local highway authorities should explore the possibility of using traffic regulation orders as a means of confining heavy traffic to a specified basic road network.
c. that the Ministry of Transport should look into the possibility of national legislation to confine heavy vehicles to major roads.

17. Traffic restriction would also be valuable in certain specific conditions. Snow clearance is hindered on some vulnerable mountain roads by ill-equipped abandoned cars blocking the route. We RECOMMEND the Ministry to explore the possibility of creating powers whereby highway authorities could ensure that vehicles were permitted to use certain roads liable to drifting snow only if they were equipped to deal with the conditions.

Parking in Urban Areas

18. We were constantly reminded of the problems of on-street parking in urban areas. Parked vehicles damage verges and footways and obstruct routine maintenance, especially such operations as sweeping, surface dressing or renewal of road markings. It is an offence under Section 117 of the Highways Act, 1959, 'wilfully' to damage any part of a highway or, under Section 121, 'wilfully' to cause obstructions in a highway. These provisions are however of limited use in carrying out routine maintenance. The exercise of the powers to

remove parked vehicles, provided under the Removal and Disposal of Vehicles Regulations, 1968, is mainly conditional on the vehicles concerned either causing obstruction or having been abandoned. The powers are exercisable by the local authority and the police rather than the highway authority.

19. There seem to be no general powers available to highway authorities to remove parked vehicles when they wish to do routine maintenance. Many authorities manage to get round this problem by attaching notices on the lamp-posts in the streets concerned requesting people to park elsewhere or by co-operation with the police who set up no-parking cones. Public co-operation seems to be achieved in such authorities particularly when the operation concerned is surface dressing. Other authorities however give no advance notice, remove parked vehicles and leave the owners to discover where their cars are when they return home. We RECOMMEND that highway authorities should have powers to remove or require the removal of vehicles parked in streets where they wish to carry out maintenance. These powers should be exercisable only after advising those concerned well in advance and should include the power to seek reimbursement of the cost of moving any vehicles which remain.

Highway Authority—Local Authority

20. We believe that all the powers we have discussed, existing, proposed and any others relevant to highways and traffic, should be exercised by a single authority. At present, as we have indicated, the various statutes grant one set of powers to the *local authority*, another to the *highway authority* and yet others to the *traffic authority*. We think greater efficiency is likely where these are the same. For example the present distinction between cleansing and scavenging means that responsibility for carrying out these over-lapping functions is generally split between different departments within local authorities. As all litter is dropped by highway (including footway) users, all highway cleansing should be regarded as a single function for which the highway authority should be responsible. The legal distinction between the two functions is out-dated and uneconomic. In our view it would be better if the interrelated powers mentioned above were exercised by the same authority. These problems would of course be solved if the Royal Commission's proposed unitary authorities were established.

Chapter 13: Effect of Statutory Undertakers' Work on Highway Maintenance

Introduction

1. Our terms of reference did not specifically include the relationship between statutory undertakers and the highway authority. However our investigation and what we learned about the impact of the work of statutory undertakers, particularly when carried out under emergency powers, on local authority actions and decisions made it impossible for us to ignore the subject.
2. We therefore looked into it to the extent which we felt was required without attempting an exhaustive survey. We did not find it necessary to carry out wide-ranging studies and relied on the experience inside the Committee and among others who helped us generously with information. Our only specific study was small scale and was designed to establish the cost of the traffic delays caused by statutory undertakers' work and to examine the possibility of a compensatory charging system.

3. Our examination in no way involves or commits the representatives of the statutory undertakers who gave us views. The statutory undertakers were not represented on the Committee, which consisted very largely of people serving in highway authorities, and our findings naturally reflect the highway authority viewpoint. We regard this chapter as a basis for renewed discussions between highway authorities and statutory undertakers rather than as a definitive solution.

Public Utilities Street Works Act 1950

Its Provisions

4. The legislation governing the laying of apparatus in streets is contained primarily in the Public Utilities Street Works Act, 1950 (PUSWA), which provides the general code of practice. Other relevant Acts are the Highways Act, 1959, the Pipelines Act, 1962 and various Public Health, Gas, Electricity, Water and Telegraph Acts which give undertakers powers to lay and maintain essential services in streets.

5. The objects of PUSWA are threefold:—

a. to provide a code to regulate the exercise of statutory powers to carry out undertakers' work in streets;
b. to provide a similar code to govern the relations between undertakers and highway authorities where roadworks affect undertakers' apparatus;

c. to provide a minimum code to regulate the relations of undertakers among themselves.

The Act does not prescribe in detail how the desired co-operation should be achieved but subsequent negotiation between the parties concerned resulted in the agreed Street Works Code of 1957.

Our Conclusions

6. We have concluded that PUSWA works to the disadvantage of highway authorities. Generally it enables statutory undertakers to carry out their function of supplying services quickly but only at others' expense. This is because the major expense of statutory undertakers' works is imposed through the damage they cause to the road fabric and the poor quality reinstatements which frequently follow them. This expense falls on the highway authority and the community at large.

7. The failure to establish a working relationship between highway authorities and statutory undertakers which, by ensuring suitable reinstatements, would reduce the inevitable damage to the road is more marked in some authorities than in others. Some highway authorities have created satisfactory working arrangements which take account of the proper management of highway maintenance and of the needs of the travelling public. Where this is not so, the most striking reason is that the provisions of PUSWA are widely disregarded (see for example para 16). We find it unfortunate that an Act of Parliament should be incompletely observed by local authorities and nationalised undertakings whose relationships it is designed to control. The Act provides for monetary penalties for non-observance. These may have seemed effective when the works were carried out by a large number of small undertakings but have become meaningless in the situation of large amalgamations which has since developed. Penalties are therefore not invoked and their existence does not prevent frequent contraventions of the Act. We conclude that the penalty system in PUSWA is totally inappropriate to the present day. We RECOMMEND that a different system be sought.

8. We believe too that misunderstanding of existing powers at working level in highway authorities and confused procedures for liaison between the two sides go far to explain the disregard for the Act and the unsatisfactory position about which we have heard so much complaint. The remainder of our comments are intended to suggest how certain specific problems might best be overcome.

Reinstatements

9. Our specific study of the effects of statutory undertakers' works on maintenance showed that by far the most important is the physical damage to the road fabric. We have not been able to estimate the costs of this damage but we have concluded that highway authorities pay the major part of it in the form of consequent increases in maintenance. If the extent of the damage caused by undertakers' openings is to be reduced, the quality of reinstatement work must be improved.

10. We believe it to be in the public interest, first that backfilling should be carried out effectively either to a sufficient degree of compaction or by using lean mix concrete so as to minimise the likelihood of future settlement and, secondly, that permanent reinstatement should follow as closely as possible on the backfilling of the opening or trench.

11. In too many cases the present system and the manner in which it is operated both by undertakers and by highway authorities lead to inadequate backfilling by undertakers. The primary obligation to backfill adequately, in accordance with sound engineering practice and the highway authority's specification, rests with the undertakers. To ensure that this is done they should themselves provide sufficient site supervision. In an ideal situation very little extra supervision by the highway authorities should be necessary. In practice, however, due to the widespread nature of the work, the vast number of individual openings and the fact that many jobs are done by sub-contractors, the site supervision provided is often found to be inadequate. Highway authorities for their part have, in many cases, provided insufficient inspectors to ensure that the undertakers supervise their work adequately. An important reason may be that the present system permits the highway authority to delay carrying out the permanent reinstatement as long as it likes, while the undertaker can carry out permanent reinstatement only with the consent of the highway authority and thereafter has a maintenance liability for a further six months. We believe that, if the reinstatement has been carried out satisfactorily, this system is unfair to the undertaker, is a dis-service to the general public, encourages badly executed work in backfilling by the undertakers and poor supervision by the highway authority.

12. To remedy this, we suggest that highway authorities should give more care and precision to their requirements for backfilling and that they and the undertakers should realise the long-term disadvantage of economising on supervisory staffs. Consideration should be given to immediate permanent reinstatement when backfilling is in lean mix concrete with no further specific maintenance liability on the undertaker. In all other reinstatements we suggest that the undertaker should have the right, subject to notifying the authority, to carry out permanent reinstatement if this has not been done by the local authority within six months of satisfactory completion of the backfilling. Whether the reinstatement is carried out by the undertaker or by the authority, we suggest for consideration that a continuing liability for maintenance should be placed upon the statutory undertaker if further settlement takes place within two years after permanent reinstatement.

13. Even though measures on the lines we have put forward should lead to a generally improved system of reinstatement, we feel that there is a case for placing upon undertakers a liability for compensation in respect of the long-term damage to the fabric of the road caused by their excavations. We suggest that there is a need for a major study to devise an appropriate charging system.

14. Our conclusions on reinstatements may be summarised as follows:—

a. Undertakers should provide sufficient site supervision to ensure that the highway authority's specifications for backfill are adhered to.

b. Highway authorities should employ sufficient staff to inspect the quality of the work while it is still in progress, before the statutory undertakers or their contractors leave a site.
c. The overall charge which highway authorities make on statutory undertakers should reflect realistically the cost of employing sufficient trench inspectors.
d. There should be a long-term study to quantify the cost of the damage imposed by statutory undertakers' works on the road fabric and to devise a suitable charging system whereby undertakers would recompense highway authorities for the cost of the necessary additional maintenance, including the higher cost of emergency openings in recently resurfaced carriageways.
e. In cases where backfilling is in lean mix concrete, openings should be permanently reinstated as soon as work has been completed.
f. In other cases, subject to backfilling having been adequately carried out, undertakers should be free to carry out permanent reinstatements after 6 months, if they have previously notified the highway authority.
g. The highway authority should retain the right to carry out permanent reinstatements for up to 6 months after completion of the undertaker's work.
h. Undertakers' responsibility for permanent reinstatements should be extended from 6 months to 2 years.
i. Each local authority should define the standards of backfill and reinstatement they require.
j. The Street Works Code should include an obligation on statutory undertakers to notify the highway authority if a reinstatement is to be carried out by a contractor and to nominate the official responsible for the contract.

15. We RECOMMEND that the Ministry should initiate a joint review of the Street Works Code and its operation; one of the objects should be to remedy highway authorities' lack of power to enforce the Code's provisions.

Emergency Works

16. The emergency provisions are generally the greatest source of friction between highway authorities and statutory undertakers. Although the provisions work as well as can be expeced in some areas, there is no doubt that the very wide definition of emergencies provided in Section 39 of PUSWA are used by undertakers to evade the notice provisions. We learned of one case in which systematic renewal of old apparatus was achieved under emergency powers. The Act defines as an emergency 'works which undertakers necessarily carry out in order to meet a statutory obligation to consumers which they are obliged to fulfil within a prescribed time'. Undertakers tend to regard their duty to provide new supplies or to re-connect supplies as justifying the use of emergency powers if insufficient warning has been given to them by developers or occupiers. We do not consider that such cases constitute a sufficient emergency to justify the avoidance of advance notice and the heavy costs this must impose on the community. Even the 12 months protection from openings accorded to newly resurfaced roads (see para 21) can be broken if the undertaker can claim that an emergency has arisen. Clearly there is a conflict of interest here with both sides understandably claiming to act under a genuine and defensible obligation.

17. A large proportion of statutory undertakers' road openings are caused by genuine emergencies, particularly in the case of the Water Boards, but we also recognise the understandable mistrust brought about by the way statutory undertakers use emergency powers. We believe that the definition in PUSWA could be further refined. We therefore suggest that an attempt should be made to itemise categories of genuine emergency for each of the statutory undertakers and that these definitions should be added to the Street Works Code. In the meantime undertakers should make greater efforts to keep within the spirit of PUSWA's definition of emergency works and should in any case notify the highway authority as soon as works have begun. Since the emergency provisions operate reasonably in some authorities, we must assume that there is scope for developing further mutual understanding on this subject. The regular meetings we propose below would provide an opportunity for more open discussion and we suggest that specific disputes over emergency works should be settled in this forum.

Notification of Works

18. There is first the question of scale. Smaller highway authorities can expect to receive several hundred notifications of road openings from statutory undertakers each year and a large county borough might well have to deal with over 6,000 such openings. The size and efficiency of the highway authority's organisation dealing with this procedure is therefore of great importance. We are dismayed to find that some highway authorities who complain about the inadequacy of the existing legal provisions do not always comply with them nor do they know the extent of their powers. Undertakers also fail: notices of road openings sometimes arrive simultaneously with notices of completion of work and a single notice may be used to cover two or more separate road openings. Generally practice falls short of that laid down in the Act.

19. The main problem is that the two sides do not keep each other sufficiently informed of advance plans. Present inadequacies may arise because no one is charged with responsibility for the co-ordination which alone could improve the situation. Practice varies widely over the country but the provisions of PUSWA seem to work most smoothly where the contacts between undertakers and authorities are formalised, for example in regular meetings. Contact at all levels clearly needs to be much improved. If regular meetings are to be of real value, both sides must be represented by persons empowered to take decisions on behalf of their organisation. Within each organisation too there must be close contact between those who attend the meetings and those who plan and co-ordinate future work programmes. Regular high-level meetings will not of themselves create an appropriate working atmosphere and we suggest that contacts at working level should be improved particularly by encouraging a better sense of co-operation. Whatever means may be devised to exchange information more freely, the important step is to regularise and formalise contact at an appropriately high level rather than to leave matters to *ad hoc* meetings, relationships based only on telephone conversations or other informal contact.

20. Notices provided by the statutory undertakers give inadequate information. They could usefully be extended to detail the area of the carriageway to be affected, the proposed hours of working, the time the job will take and the method of work. On the basis of our evidence on delay costs (see paras 23–25) we suggest that these details should be provided whenever work affects important traffic routes as defined by the local highway authority.

21. There are also problems in the provisions themselves. The period of three months' notice which a highway authority must give of its intentions if it wishes to protect a road from openings for 12 months after resurfacing is rarely sufficient for the undertakers to take advantage of the situation, since they often need to wait up to 12 months to obtain new apparatus. Similarly highway authorities have difficulty in making firm plans for resurfacing beyond the financial year and may need to change their resurfacing plans at short notice. We believe that co-operation on both sides could go some way towards overcoming these particular problems.

22. Our conclusions on notifications may be summarised as follows:—

a. Highway authorities should ensure that officers are fully conversant with the legal provisions. They should make more use of their powers under PUSWA to enforce compliance with the notification procedure.
b. There should be regular, (say quarterly), formal meetings between all the bodies concerned to exchange programmes, discuss difficulties and generally to act as a forum for co-ordination in addition to the constant contact which should be maintained throughout the year. (These meetings should not be confined to highway maintenance but should cover all road works proposed by the highway authority).
c. Statutory undertakers' notifications of proposed works should, where these affect heavily trafficked routes, include details and a programme of the work involved.
d. Highway authorities and statutory undertakers should give tentative informal notice of proposed works as far ahead as possible and not limit themselves to the notification periods laid down in PUSWA.

Interference with Traffic

23. Highway authorities generally have no powers to ensure that undertakers carry out their work on certain days or at certain times of the day. Some authorities manage to secure effective co-operation so that busy roads are not opened during peak hours or town centre roads during the week. In the absence of co-operation there are no specific powers available to the highway authority.

24. Our study into the traffic aspect of undertakers' works has shown that both undertakers and highway authorities are uncertain of their powers and of the role the police might play in solving traffic problems. We have also found that the cost of the consequent traffic delays is not a major factor compared with that of damage to the road; the minority of cases of delays which merit attention are more often in urban areas where traffic is particularly heavy. This conclusion

is confirmed by the RRL in a study which showed that although delay costs imposed by maintenance works on heavily trafficked roads could be very high, they were smaller than might have been expected on less busy roads, where the traffic was generally within the road's capacity. However, the general growth in traffic can be expected to increase the extent of delays in the future.

25. We believe that undertakers should be more prepared to accept the need to work in off-peak hours in some cases. The police should be informed as a matter of course by the highway authority of proposed road openings in heavily trafficked routes and should be brought into discusions if traffic problems are foreseen. Planning responsibility should however be placed firmly on the highway authority. Highway authorities should have wider powers to control the timing of statutory undertakers' works in the carriageway. We RECOMMEND that in any future legislation they should be given powers to require undertakers to work at certain times of the day under specific traffic conditions.

Placing of Apparatus

26. The principle embodied in current legislation is that statutory undertakers have a right to lay their apparatus in highway land. It is in the interests of both parties that the apparatus should be placed under the verge or footway wherever possible. The statutory undertakers already aim to achieve this but space is not always available. Our investigations suggest that about two-thirds of statutory undertakers' openings are in a footway or verge rather than in the road but we believe there is scope to improve the position still further. Although we should prefer more statutory undertakers' apparatus to be placed completely outside highway land, it is not necessarily in the undertakers' interests or in some cases their powers to attempt this.

27. We have concluded that the siting of undertakers' apparatus merits more attention, especially as the highway authority, the statutory undertaker and the road user have, individually, insufficient incentive to meet the costs of placing apparatus entirely clear of the carriageway. The following suggestions on the placing of apparatus should be considered:—

a. The trend towards placing apparatus off the carriageway should continue.
b. The whole question of the economics of the siting of apparatus, including social costs and problems of land availability, should be given attention.

Chapter 14: Investment in Highway Maintenance

Introduction

1. Our terms of reference implied an expectation that we should find ways of enabling the government and the local highway authorities to fix more effectively the right level of resources to be devoted to highway maintenance. This we claim to have done. When our proposals have been fully implemented their combined effect will allow a realistic estimate to be made of the investment the country should be making in highway maintenance. However, knowing that some time must elapse before this objective estimate can be made, we felt obliged to review the present level of expenditure, and to attempt an immediate answer to the question whether we are spending the right amount in the right way on road maintenance.

2. The obvious starting point would have been a comparison over a period of the trend in highway maintenance expenditure with the expansion of the road network and the growth in the volume of traffic. Unhappily such a study was impracticable because of changes made in accounting classifications. Reliance had to be placed on an examination of the present load and direction of expenditure, unaided either by standards or by historical data. This chapter is therefore a snapshot of the present position; the remainder of our report is concerned with the future.

3. For the present purpose we have considered roads in three broad categories: (a) major roads, (b) little-used minor roads, and (c) other non-principal rural roads. Additionally we considered whether, taking roads as a whole, the right proportions of resources are devoted to maintaining the structure as compared with those expended on safety and amenity functions.

4. We decided that the problem could best be approached by examining the work being done *at the margin*, in other words in that area where authorities have to make a choice between a selection of schemes not all of which can be financed from their budget. We therefore asked ourselves the following questions. What evidence is there that, at the margin, the work being done or not being done is either necessary or unnecessary? Could we say with confidence that at the present time expenditure could and should be reduced because it is devoted at the margin to tasks which could be left undone? Or is there a situation in which all marginal tasks, both those for which there are adequate funds and those which cannot be done, are of such importance that they can be neglected only at the peril of the road, with the result that funds are constantly having to be made available in an emergency and out-of-programme context to make up for the inadequacies of the level of planned maintenance expenditure?

Major Roads

5. The Road Research Laboratory's study of standards points to a general running-down of the quality of major roads. Indeed, this is the experience of everyone using our heavily-trafficked roads other than those of comparatively recent construction or reconstruction. One method of judging this more objectively is to consider the roads at the margin, in this case roads where major reconstruction works have had to be carried out in recent years because of foundation failures. This should indicate the amount of similar work which ought to be done before failure actually occurs but which cannot be included in the programme for lack of resources.

6. Evidence collected for us by the County Surveyors' Society showed that 2,000 miles of road (not all major roads) had failed and required major reconstruction works because of inadequate maintenance and that a further 6,000 miles were judged to be liable to suffer the same fate. Two or three times this mileage might now be at risk. The Society thought that continued inadequate maintenance was likely to lead to the failure of about 300 miles of road each year. The mileage of roads which had failed solely due to use by heavy traffic was less but might amount to a further 100 miles each year.

7. We also enquired into the marginal tasks which are being neglected or which perforce have had to be injected at fairly short notice into the Ministry's trunk road and motorway maintenance programme to avoid serious consequences. We find that in 1970/71 work on two roads and four bridges has had to be undertaken additionally to the original trunk road maintenance programme, and in most cases in place of some other only slightly less urgent work. The additional work is costing nearly £0·7m, which is about 40% of the funds available for the reconstruction of bridges and carriageways. The two road schemes were needed to repair severe and progressive deterioration of the carriageway resulting from water penetration. Three of the four bridges needed urgent attention primarily because of damage caused by the increasing weight of modern traffic. Only just over 10% of the trunk road maintenance programme is currently devoted to major repairs to bridges and carriageway foundations.

8. This information is not in itself conclusive but, taken with the widely expressed views, the manifestly obvious state of many of our major roads and the increasingly onerous requirement to maintain bridges, many of them quite old, in a fit condition carry modern traffic, it suggests that continued economies on structural maintenance are likely to lead to more serious failure in the near future. In our view the time has come to rectify the position.

Little-Used Minor Roads

9. The question was whether traditional methods and standards were leading to over-maintenance of these roads and whether savings might therefore be possible. Our first piece of evidence was the LGORU study on the value of roads which suggested that some minor roads did not justify any maintenance. By a simple extension of that study we tried to find out whether it would be

practicable to suggest a policy of *minimum maintenance* for these very little-used roads on which expenditure was least justified and, if so, what savings would accrue. By minimum maintenance we meant that the road would be allowed to fall into a state which, although still usable, would oblige vehicles to limit their speed to 5 mph. (This extreme approach was dictated to some extent by lack of data for a more refined exercise). Details of the study carried out in two counties are given in Appendix 10.

10. The sample was not sufficient to allow a precise assessment of possible savings to be made. It is however clear that a policy of minimum maintenance for a not inconsiderable mileage of rural roads would produce only a small proportionate saving in total maintenance costs. The percentage change, probably 1% or 2% of total maintenance expenditure, could not significantly alter budgeting policy. The undoubted social and amenity costs, particularly to frontagers, that minimum maintenance would impose must also be borne in mind.

Other Non-Principal Rural Roads

11. We then considered the general level of expenditure on other non-principal rural roads, ie those minor roads with too much traffic to allow a policy of minimum maintenance. A reasonable figure for minimum expenditure on little-used roads, sufficient only to preserve their waterproof surface and prevent them from becoming founderous, lies between £100 and £150 per annum per mile. The average expenditure at present on Class III and unclassified roads in county areas is of the order of £400 per mile. Many of these may carry a good deal of traffic, and others will for various reasons justify more than the minimum treatment for preservation. However there could be scope for economies here without serious detriment to movement or amenity. The total amount now spent annually on these roads is over £40m. and the savings could thus be appreciable. Oxfordshire County Council provided some significant evidence in a report which sets out a scheme for reducing the surface areas to be maintained. Details are given in Appendix 10. In Oxfordshire savings of 10% initially and 25% in due course are planned on expenditure on non-principal roads; but we do not think it is possible to extrapolate these figures to arrive at estimates on a national basis. No similar evidence was available about roads of this category in urban areas.

12. Increased savings on minor roads become practicable if large and heavy traffic is excluded from using them, apart from purposes of access. In many cases such roads are now becoming through routes or alternative routes because of increased traffic volumes. Many of them are suffering from damage particularly to the haunches due to frequent use by vehicles of greater width and with much heavier axle weights than before. While we recognise the very great difficulties involved, we consider that an essential development of modern traffic management must be the channelling, by regulation if necessary, of large and heavy traffic (in the sense of the volume, the width and the axle weight) to major roads maintained to a high standard. The alternative is to accept the heavy costs,

including widening and reconstruction, associated with unrestricted use of weak and narrow minor roads. Hence our suggestion in Chapter 12 that the Ministry of Transport should consider the introduction of national regulations, wider in purpose and scope than those possible under local regulations. They should define the roads to which the heavier and wider vehicles should be confined.

Proportionate Expenditure on Structural and Other Functions

13. The proportions spent on the same class and type of road on structural maintenance of the carriageway and on other functions vary between different authorities. For example for principal roads the percentage of total maintenance expenditure devoted to the structure can range anywhere up to 50% in urban authorities and anywhere from 50% upwards in counties. A lower proportion is to be expected in urban areas and in more urbanised counties because of the greater need for expenditure for safety purposes and cleansing and also because of variations in construction standards. These factors are, however, insufficient to explain such wide divergencies. We formed the opinion that on principal roads in urban areas the proportionate expenditure on structural maintenance should be of the order of 50% with probably a somewhat higher figure in most counties. We hope that highway authorities will look at their proportionate expenditure in this way pending the introduction of the more sophisticated methods of programming of expenditure recommended in our report.

Conclusions

14. In part increased expenditure on the structure of major roads could be offset by savings on minor roads. Further, in some authorities there is a case for deliberately switching money from amenity and aids to movement to structural maintenance. In the longer run some of the costs of higher maintenance standards should be met from the savings achieved by better administration and management referred to in Chapter 8. But these effects are unlikely to be felt early enough or to a sufficient extent to deal with the consequences of enforced economies on our major roads in the past. Although some increase in maintenance expenditure will be needed to cope with the growth of traffic and the expansion of the road network, we believe that an even greater increase should be planned for major roads over the next few years in order to compensate for past restrictions on the level of funds allocated.

Chapter 15: Ensuring Implementation

Introduction

1. We believe that when implemented our recommendations will bring great benefits to the elected members of local authorities, their officers and central government. We therefore conclude with our views on the process of implementation.

2. Putting the report into action must to some extent depend on decisions by the three central departments and the local authority associations which sponsored our work. We hope that they will be persuaded of the need to act quickly. About half of our recommendations however do not call for initial nation-wide decisions and can be implemented immediately by individual highway authorities, both local and central. For convenience we have grouped our recommendations in Part II of the next chapter according to the bodies to which they are addressed; sections A, B and C are all capable of immediate action. We suggest that local highway authorities and the central departments concerned should set themselves a timetable for implementation.

Local Authorities

3. The greater part of our recommendations are addressed to local authorities in whose hands lie the planning and management of most highway maintenance. They concern both members and officers. Upon elected representatives rests the ultimate responsibility for ensuring that our recommendations are adopted, that funds are wisely allocated, and that the local authority and its committees are supplied with the information essential for the final control and direction. This does not imply that elected members are required to undertake day to day supervision or concern themselves with detailed implementation of our proposals. On the contrary they have to guard against the temptation—ever present in the case of highway maintenance—to over-much intervention at ground level. But it is of the greatest importance that the elected representatives should understand what is involved and be ready to take the major policy decisions to enable the officers of the local authorities to move, subject to the Council's authority, in the directions we have outlined. Councillors will, we hope, sense from this report what steps they can take in the particular circumstances to further our recommendations. The officers have however the main burden. They should with all speed examine their organisation in the light of our report, initiate such reforms as are within their competence and make appropriate recommendations on the remainder. Their continuing duty is to keep the organisation geared to executing agreed policy with maximum efficiency, taking full advantage of

technical developments as they emerge. Our many contacts with the appropriate officers during the course of our work have convinced us that there is no lack of either the will or the ability to do this.

4. Drastic changes in the structure of local government are in contemplation, but the action which we propose need not and should not await them. The benefits arising should be sought straightaway. They will facilitate rather than hinder structural reorganisation.

The Government Departments

5. The government departments—the Ministry of Transport, the Scottish Development Department and the Welsh Office—have a dual role to play: applying our recommendations to the roads under their control, ie the trunk roads, and encouraging local authorities to adopt them for the remaining roads. The departments are in a position to ensure that our recommendations are implemented uniformly on trunk roads.

6. We have recommended that the departments should introduce the new methods on trunk roads as rapidly as possible, partly because they are needed and partly to encourage local authorities to accept them. Although we expect the proposed changes to develop in consultation, we regard it as a matter of urgency that the departments should take the initiative. Local highway authorities are unlikely to retain different methods of management on their own roads from those which they use as agent authorities. Prompt action on trunk roads would therefore act as an effective catalyst.

Continuing Committee

7. However willing many authorities may be to proceed quickly with the implementation of our proposals, there is a risk, indeed a certainty, that development will be piecemeal and ineffective unless there is some central effort to ensure that changes are common to all authorities and adopted over the same time scale. If there were no focal point to which to turn for help, those authorities in most need of improvement might make no move at all while others would progress unevenly. Nationwide arrangements are also required to implement some of the recommendations; examples are the central collection of data or the institution and following up of research. The central departments must clearly share with the local authorities the responsibility for setting up an appropriate organisation to meet both these needs.

8. We propose that central government and local authorities should jointly establish a permanent continuing committee. Its role would be to pursue on a national front the implementation of our recommendations, to keep abreast of new techniques and developments, to initiate and foster research, and generally to ensure that local highway authorities receive all the help they need. It would maintain close relations with the LGTB and LAMSAC and other appropriate organisations, and would report annually to the central departments and local authority associations.

9. Implementation would be facilitated if, possibly under the auspices of the continuing committee, the departments could enter into special relationships with a few individual local authorities with a view to working up model arrangements as a guide for others. This would enable both the central departments and local authorities to see exactly how the proposals affect working methods. The departments could then more easily keep local authorities in touch with developments. In addition to these special relationships, we think that it would be helpful if the continuing committee were to encourage the departments to establish regular liaison arrangements with major highway authorities in order to ensure a degree of consistency, a rapid exchange of information and a cross-fertilisation of ideas covering both administrative and technical practice. The information obtained would also provide many necessary data for maintenance research.

10. The committee will need an expert secretariat which, in addition to maintaining contacts with the three departments and local authorities, will keep abreast of developing management and appraisal techniques. This secretariat would be the obvious place for the centralisation and dissemination of the statistics discussed in Chapter 11. The secretariat could be located in the Ministry of Transport or set up *ad hoc*. No question of principle is involved, but we see many practical advantages in having the unit within the Ministry. Placed there it would have access to technical facilities (computer, economic unit etc.), could work closely with the trunk road maintenance unit and would have the general support of the department's arrangements. It would be ideally situated for bringing together all the threads.

Other Bodies

11. Some of the work we have shown to be required in the maintenance field consists of projects for further research. These will in the main be carried out by professional, management or research organisations such as the RRL or the LGORU to which the continuing committee will have access. They include the work associated with the establishment of objective standards and the use of newly developed apparatus for measuring the condition of roads. The continuing committee should be in a position to influence and in some degree co-ordinate research into the relevant specialisms and to ensure that advances in more generalised disciplines, eg management, are absorbed into highway maintenance practice.

Recommendations

12. We RECOMMEND that in order to implement the proposals we have made in this report:—

a. The sponsoring authorities should appoint as soon as possible a small continuing committee representative of the departments and the local highway authorities to foster progress.

b. The secretariat of such a committee might be placed with the Ministry of Transport.
c. Special relationships should be developed between the departments and a few local authorities to provide a reference point for other authorities during the development period.
d. The continuing committee should encourage regular liaison arrangements between the departments and major highway authorities on all aspects of maintenance.

Chapter 16: Recommendations

Part I: The Recommendations Listed According to the Chapters of the Report

SIZE OF MAINTENANCE PROBLEM: Chapter 3

1. When the distribution formula for the rate support grant is next reviewed, the government should bear in mind that sufficient data may be available to enable them to include in the formula a weighting factor which would reflect more adequately than at present authorities' maintenance needs. (4)*

MAINTENANCE STANDARDS: Chapter 4

2. The standards set out in Appendix 1 should be adopted and used immediately by highway authorities for the planning and management of their maintenance programmes. (21)

3. Central and local government should co-operate to the full in the development of objective standards and both short-term and long-term economic studies should be simultaneously set in hand. (21)

4. All highway authorities should make full use of the new apparatus now becoming available for the measurement of a road's condition, arranging if necessary to share more costly items. (21)

ALLOCATING RESOURCES: Chapter 5

5. Authorities should use a maintenance rating system as the basis of regular, documented inspection of all their roads in the manner set out in Appendix 2. (14)

6. Authorities should produce firm three year maintenance programmes based on longer-term improvement plans. (19)

7. Authorities should use economic assessments to determine the relative priorities of structural maintenance projects. (19)

8. Local highway authorities should operate the budgeting system in a way which avoids the end-of-year problem and permits the introduction of rolling, perhaps three year, budgets for maintenance. (21)

9. The Road Research Laboratory, the government departments and local authority associations should co-operate in a series of practical experiments over a wide variety of roads and areas to develop the full maintenance rating system for general use as soon as possible. (22)

10. A further study should be made to investigate in greater depth methods of estimating a road's value in order to assess more precisely the importance in this value of factors other than traffic flow. (25)

*Numbers in brackets refer to the paragraphs in which the recommendations are made.

11. In the continuing research into the application of output budgeting to maintenance, the local authority associations, the professional institutions and the Ministry should co-operate in a series of practical studies. (29)

LABOUR PRODUCTIVITY: Chapter 6

12. Local authorities without work study facilities should, within 6 months of publication of this report, measure their productivity using the figures in Appendix 4. (8)

13. Individual authorities should press ahead with work study followed by incentive schemes. (17)

14. The local authority associations should review the progress of work study based on incentive schemes generally. This might be done in conjunction with the Local Authorities Management Services and Computer Committee. (17)

15. Authorities at present without incentive schemes but which could adopt a work study based scheme within a reasonable period should work straight for a full scheme. (27)

16. Counties for which this is not possible should try to arrange a transplant scheme. (27)

17. If they have neither work study nor other appropriate facilities such as access to a transplant scheme authorities should adopt an interim incentive scheme. Data recorded for the interim scheme should be used to assess Effective Performance. (27)

18. The introduction of an interim or transplant scheme must not be allowed to delay progress to a work study based incentive scheme. (27)

TRAINING: Chapter 7

19. The government should ensure that, during the period while local authorities are not regarded as covered by the Industrial Training Act, 1964, advances already made for training local government employees are not wasted. (9)

20. Authorities should adopt a staffing policy sufficiently flexible to permit release for off-the-job training. (26)

21. Authorities should appoint an officer in their maintenance organisation to be formally responsible for training and management development. (28)

22. More authorities should co-operate with local contractors in the provision of training. (29)

23. The Roadwork 99 course should be used primarily for young entrants who intend to specialise in a craft or to proceed to a supervisory post. (38)

24. A basic roadwork course should be made available to far greater numbers than at present. (38)

25. More practical training in modules of individual skills should be devised for older entrants. (38)

26. The Ministry of Transport should join with the local authority associations to commission a simple graphic training manual for roadwork: we emphasise *graphic* because we think both the subject and the trainees suited to this method of presentation. (38)

27. There should be an increased provision of courses for foremen's training. (41)

28. There should be far greater encouragement to foremen to attend available training courses. (41)

29. The Local Government Training Board and the Construction Industry Training Board should proceed as quickly as possible to establish the proposed regional training centres. We would hope that the Boards might provide a timetable for their planned expansion of training since it is they who have most scope for improving the present situation. (41)

ORGANISATION AND ADMINISTRATION: Chapter 8

30. All authorities should reconsider their maintenance organisation in the light of our comments in Chapter 8. (3)

31. County divisions in areas of average road density should not be smaller than 400–450 miles of road. (4)

32. Authorities should use up-to-date written job descriptions for each member of the management staff. (5)

33. Authorities should produce sets of standing instructions in terms appropriate to the grades of staff for whom they are intended, keep them up-to-date and see that they are used. (6)

34. Authorities should employ a much greater proportion of technicians and offer them suitable training and attractive career prospects. (7)

35. Every authority should have a work planning section supported by a plant manager. (14)

36. All large or expensive items of plant should be controlled centrally so that their usage may be programmed by the plant manager in accordance with the works plan. (14)

37. The responsibilities of the work planning section should cover the programming of all resurfacing and surface dressing work, whether to be done by direct labour or contract. (15)

38. County councils and the local highway authorities within their areas should co-ordinate their resurfacing and surface dressing programmes as far as possible. (16)

39. All authorities should review regularly the possibility of reorganising their work in order to take the fullest advantage of market conditions. (20)

40. County authorities should, if they are to gain the maximum benefit from bulk buying, include the needs of their constituent authorities in the quantities on which the annual tender is based. (22)

41. Authorities should order materials in bulk whenever possible, if necessary co-operating with their neighbours. (22)

42. For maintenance jobs costing less than £1,000 authorities should use either a schedule of rates or individual quotations as the means of selecting a contractor. (23)

43. Specifications need only refer to standard publications such as Ministry of Transport specifications, Institution of Civil Engineers' Conditions of Contract, Road Research Laboratory Notes and British Standards. Quotation in full adds to an authority's costs and is a waste of time to the tenderer. (25)

44. Results of tenders should be released within three weeks of the closing date. (25)

45. There should be further standardisation of tender forms. (25)

46. Authorities should not be deterred from adopting desirable changes in procedure merely because they may involve an increase in administrative staff. (27)

CONTROL OF WORK: Chapter 9

47. Authorities should produce their work study data in a form primarily suited to management control. (4)

48. Authorities should pay careful attention to their plant policies in the ways set out in Appendices 3 and 5 of this report. (9)

49. Each authority should introduce a control system on the lines set out in Appendix 5. (17)

TRUNK ROAD MAINTENANCE CONTROL: Chapter 10

50. The proposed initial standards and methods of fund allocation and of selecting priorities should be introduced on trunk roads as soon as possible. (3)

51. The three government departments concerned should terminate all agency appointments relating to uneconomic mileages of trunk road. (4)

52. The departments should notify agents of their firm allocation considerably before the beginning of the financial year to which it applies. (11)

53. Agent authorities should, at the provisional estimate stage, supply DREs/the departments with their estimated unit cost for each operation. (17)

54. The returns giving details of the proposed trunk road maintenance programme should include, for resurfacing and surface dressing, the area of road to be treated and the relevant materials specification. (17)

55. Trunk road programme returns should collect data under the same headings for motorways and all-purpose trunk roads. (17)

56. The Ministry of Transport should institute a firm three year maintenance programme for trunk roads based on a long-term improvement programme. (20)

57. The departments should notify DREs/CREs of the funds likely to be available for at least 3 years ahead, so that agent authorities can plan trunk road maintenance over the same time span as maintenance of their own roads. (20)

58. A new return should be made by agent authorities relating expenditure incurred to work done, using the same headings as on the detailed proposed works form so that achievement may be compared with the estimate. (22)

59. The departments should develop the necessary managerial and engineering organisation to ensure that control of trunk road maintenance is sufficient to achieve the objectives set out in Chapter 10. (23)

AVAILABLE DATA: Chapter 11

60. The departments should consider urgently how they may collect, for the same lengths of trunk road, data covering details of traffic flows, road geometry and maintenance expenditure under the proposed standard headings. (7)

61. Highway authorities should keep sufficient records of average annual traffic flows on all their roads, using sampling techniques wherever possible, to be able to determine reliably the average usage of the whole of their network by the categories of road defined in Chapter 4. (11)

62. The heads of account set out in Chapter 11 should be adopted by all local authorities and also by the three central departments responsible for trunk roads and motorways. (12)

63. The Ministry of Transport and the local authority associations should co-operate in producing a standard list of maintenance outputs and should study the subject in conjunction with work study systems. (16)

64. The three central government departments concerned and the local authority associations should co-operate to set up a central highway maintenance data unit. (19)

65. Improved manpower statistics should be collected for those employed on highway work, identifying by grade the numbers engaged on maintenance. (22)

MAINTENANCE AUTHORITIES: Chapter 12

66. The proposed larger highway authorities should retain full responsibility for all aspects of highway maintenance in their areas. (10)

67. Legal rights of *claiming* and *delegation* should cease. (10)

68. Further consideration should be given to the possibility of empowering highway authorities to secure advance contributions towards the cost of road strengthening in appropriate cases. (13)

69. The Ministry of Transport should promote any changes in highway authorities' liability for non-feasance necessary to enable them to maintain only a specified network of roads in a state suited to all traffic. (16)

70. All local highway authorities should explore the possibility of using traffic regulation orders as a means of confining heavy traffic to a specified basic road network. (16)

71. The Ministry of Transport should look into the possibility of national legislation to confine heavy vehicles to major roads. (16)

72. The Ministry should explore the possibility of creating powers whereby highway authorities could ensure that vehicles were permitted to use certain roads liable to drifting snow only if they were equipped to deal with the conditions. (17)

73. Highway authorities should have powers to remove or require the removal of vehicles parked in streets where they wish to carry out maintenance. These powers should be exercisable only after advising those concerned well in advance and should include the power to seek reimbursement of the cost of moving any vehicles which remain. (19)

EFFECT OF STATUTORY UNDERTAKERS' WORK ON HIGHWAY MAINTENANCE: Chapter 13

74. A new penalty system for non-observance of the Public Utilities Street Works Act, 1950, suited to present circumstances, should be sought. (7)

75. The Ministry of Transport should initiate a joint review of the Street Works Code and its operation; one of the objects should be to remedy highway authorities' lack of power to enforce the Code's provisions. (15)

76. In any future legislation, highway authorities should be given powers to require undertakers to work at certain times of the day under specific traffic conditions. (25)

ENSURING IMPLEMENTATION: Chapter 15

77. The authorities sponsoring this Committee should appoint as soon as possible a small continuing committee representative of the departments and the local highway authorities to foster progress. (12)

78. The secretariat of such a small committee might be placed with the Ministry of Transport. (12)

79. Special relationships should be developed between the departments and a few local authorities to provide a reference point for other authorities during the development period. (12)

80. The continuing committee should encourage regular liaison arrangements between the departments and major highway authorities on all aspects of maintenance. (12)

Part II: The Recommendations Listed According to the Bodies to which they are addressed

A. Addressed to all Highway Authorities, Central and Local

1. The standards set out in Appendix 1 should be adopted and used immediately by highway authorities for the planning and management of their maintenance programmes. (4:21)*

2. Authorities should use a maintenance rating system as the basis of regular, documented inspection of all their roads in the manner set out in Appendix 2. (5:14)

3. Authorities should produce firm three year programmes based on longer-term improvement plans. (5:19)

4. Authorities should use economic assessments to determine the relative priorities of structural maintenance projects. (5:19)

5. Authorities should pay careful attention to their plant policies in the ways set out in Appendices 3 and 5 of this report. (9:9)

6. The heads of account set out in Chapter 11 should be adopted by all local authorities and also by the three central departments responsible for trunk roads and motorways. (11:12)

7. Highway authorities should keep sufficient records of average annual traffic flows on all their roads, using sampling techniques wherever possible, to be able to determine reliably the average usage of the whole of their network by the categories of road defined in Chapter 4. (11:11)

8. All highway authorities should make full use of the new apparatus now becoming available for the measurement of a road's condition, arranging if necessary to share more costly items. (4:21)

9. Specifications need only refer to standard publications such as Ministry of Transport specifications, Institution of Civil Engineers' Conditions of Contract, Road Research Laboratory Notes and British Standards. Quotation in full adds to authorities' costs and is a waste of time to the tenderer. (8:25)

10. Results of tenders should be released within three weeks of the closing date. (8:25)

F. Addressed to Local Highway Authorities

1. Local highway authorities should operate the budgeting system in a way which avoids the end-of-year problem and permits the introduction of rolling, perhaps three year, budgets for maintenance. (5:21)

2. Local authorities without work study facilities should, within 6 months of publication of this report, measure their productivity using the figures in Appendix 4. (6:8)

*Numbers in brackets refer to the chapter and paragraph respectively in which the recommendations are made.

3. Individual authorities should press ahead with work study followed by incentive schemes. (6:17)

4. Authorities should adopt a staffing policy sufficiently flexible to permit release for off-the-job training. (6:26)

5. Authorities at present without incentive schemes but which could adopt a work study based scheme within a reasonable period should work straight for a full scheme. (6:27)

6. Counties for which this is not possible should try to arrange a transplant scheme. (6:27)

7. If they have neither work study nor other appropriate facilities such as access to a transplant scheme authorities should adopt an interim incentive scheme. Data recorded for the interim scheme should be used to assess Effective Performance. (6:27)

8. The introduction of an interim or transplant scheme must not be allowed to delay progress to a work study based incentive scheme. (6:27)

9. Authorities should appoint an officer in their maintenance organisation to be formally responsible for training and management development. (7:28)

10. More authorities should co-operate with local contractors in the provision of training. (7:29)

11. There should be far greater encouragement to foremen to attend available training courses. (7:41)

12. All authorities should reconsider their maintenance organisation in the light of our comments in Chapter 8. (8:3)

13. County divisions in areas of average road density should not be smaller than 400-450 miles of road. (8:4)

14. Authorities should use up-to-date written job descriptions for each member of the management staff. (8:5)

15. Authorities should produce sets of standing instructions in terms appropriate to the grades of staff for whom they are intended, keep them up-to-date and see that they are used. (8:6)

16. Authorities should employ a much greater proportion of technicians and offer them suitable training and attractive career prospects. (8:7)

17. Every authority should have a work planning section supported by a plant manager. (8:14)

18. The responsibilities of the work planning section should cover the programming of all resurfacing and surface dressing work, whether to be done by direct labour or contract. (8:15)

19. All large or expensive items of plant should be controlled centrally so that their usage may be programmed by the plant manager in accordance with the works plan. (8:14)

20. County councils and the local highway authorities within their areas should co-ordinate their resurfacing and surface dressing programmes as far as possible. (8:16)

21. All authorities should review regularly the possibility of reorganising their work in order to take the fullest advantage of market conditions. (8:20)

22. County authorities should if they are to gain the maximum benefit from bulk buying, include the needs of their constituent authorities in the quantities on which the annual tender is based. (8:22)

23. Authorities should order materials in bulk whenever possible, if necessary co-operating with their neighbours. (8:22)

24. For maintenance jobs costing less than £1,000 authorities should use either a schedule of rates or individual quotations as the means of selecting a contractor. (8:23)

25. Authorities should not be deterred from adopting desirable changes in procedure merely because they may involve an increase in administrative staff. (8:27)

26. Authorities should produce their work study data in a form primarily suited to management control. (9:4)

27. Each authority should introduce a control system on the lines set out in Appendix 5. (9:17)

28. All local highway authorities should explore the possibility of using traffic regulation orders as a means of confining heavy traffic to a specified basic road network. (12:10)

29. The Roadwork 99 course should be used primarily for young entrants who intend to specialise in a craft or to proceed to a supervisory post. (7:38)

C. Addressed to the Ministry of Transport, the Scottish Office and the Welsh Office as Highway Authorities

1. The proposed initial standards and methods of fund allocation and of selecting priorities should be introduced on trunk roads as soon as possible. (10:3)

2. The three government departments concerned should terminate all agency appointments relating to uneconomic mileages of trunk road. (10:4)

3. The departments should notify agents of their firm allocation considerably before the beginning of the financial year to which it applies. (10:11)

4. The departments should arrange for agent authorities to supply to DREs, at the provisional estimate stage, their estimated unit cost for each operation. (10:17)

5. The returns giving details of the proposed trunk road maintenance programme should include, for resurfacing and surface dressing, the area of road to be treated and the relevant materials specification. (10:17)

6. Trunk road programme returns should collect data under the same headings for motorways and all-purpose trunk roads. (10:17)

7. The Ministry of Transport should institute a firm three year maintenance programme for trunk roads based on a long-term improvement programme. (10:20)

8. The departments should notify DREs/CREs of the funds likely to be available for at least three years ahead, so that agent authorities can plan trunk road maintenance over the same time span as maintenance of their own roads. (10:20)

9. The departments should arrange for a new return to be made by agent authorities relating expenditure incurred to work done, using the same headings as on the detailed proposed works form so that achievement may be compared with the estimate. (10:22)

10. The departments should develop the necessary managerial and engineering organisation to ensure that control of trunk road maintenance is sufficient to achieve the objectives set out in Chapter 10. (10:23)

11. The departments should consider urgently how they may collect, for the same lengths of trunk road, data covering details of traffic flows, road geometry and maintenance expenditure under the proposed standard headings. (11:7)

D. Addressed to the Ministry of Transport and other Central Government Departments

1. When the distribution formula for the rate support grant is next reviewed, the government should bear in mind that sufficient data may be available to enable them to include in the formula a weighting factor which would reflect more adequately than at present authorities' maintenance needs. (3:4)

2. The government should ensure that, during the period while local authorities are not regarded as covered by the Industrial Training Act, 1964, advances already made for training local government employees are not wasted. (7:9)

3. Improved manpower statistics should be collected for those employed on highway work, identifying by grade the numbers engaged on maintenance. (11:22)

4. The proposed larger highway authorities should retain full responsibility for all aspects of highway maintenance in their areas. (12:10)

5. Legal rights of *claiming* and *delegation* should cease. (12:10)

6. Further consideration should be given to the possibility of empowering highway authorities to secure advance contributions towards the cost of road strengthening in appropriate cases. (12:13)

7. The Ministry of Transport should promote any changes in highway authorities' liability for non-feasance necessary to enable them to maintain only a specified network of roads in a state suited for all traffic. (12:16)

8. The Ministry of Transport should look into the possibility of national legislation to confine heavy vehicles to major roads. (12:16)

9. The Ministry of Transport should explore the possibility of creating powers whereby highway authorities could ensure that vehicles were permitted to use certain roads liable to drifting snow only if they were equipped to deal with the conditions. (12:17)

10. Highway authorities should have powers to remove or require the removal of vehicles parked in streets where they wish to carry out maintenance. These powers should be exercisable only after advising those concerned well in advance and should include the power to seek reimbursement of the cost of moving any vehicles which remain. (12:19)

11. A new penalty system for non-observance of the Public Utilities Street Works Act, 1950, suited to present circumstances, should be sought. (13:7)

12. The Ministry of Transport should initiate a joint review of the Street Works Code and its operation; one of the objects should be to remedy highway authorities' lack of power to enforce the Code's provisions. (13:15)

13. In any future legislation, highway authorities should be given powers to require statutory undertakers to work at certain times of the day under specific traffic conditions. (13:25)

E. Addressed to Central and Local Government in Co-operation

1. Central and local government should co-operate to the full in the urgent development of objective standards and both short-term and long-term economic studies should be simultaneously set in hand. (4:21)

2. The Road Research Laboratory, the government departments and the local authority associations should co-operate in a series of practical experiments over a wide variety of roads and areas to develop the full maintenance rating system for general use as soon as possible. (5:22)

3. A further study should be made to investigate in greater depth methods of estimating a road's value in order to assess more precisely the importance in this value of factors other than traffic flow. (5:25)

4. In the continuing research into the application of output budgeting to maintenance, the Ministry of Transport, the local authority associations and the professional institutions should co-operate in a series of practical studies. (5:29)

5. The Ministry of Transport should join with the local authority associations to commission a simple graphic training manual for roadwork: we emphasise *graphic* because we think both the subject and the trainees suited to this method of presentation. (7:38)

6. The Ministry of Transport and the local authority associations should co-operate in producing a standard list of maintenance outputs and should study the subject in conjunction with work study systems. (11:16)

7. The three central government departments concerned and the local authority associations should co-operate to set up a central highway maintenance data unit. (11:19)

F. Addressed to the Local Authority Associations and Other Bodies

1. The local authority associations should review the progress of work study based incentive schemes generally. This might be done in conjunction with the Local Authorities Management Services and Computer Committee. (6:17)

2. There should be further standardisation of tender forms. (8:25)

3. A basic roadwork course should be made available to far greater numbers than at present. (7:38)

4. More practical training, in modules of individual skills, should be devised for older entrants. (7:38)

5. There should be an increased provision of courses for foremen's training. (7:41)

6. The Local Government Training Board and the Construction Industry Training Board should proceed as quickly as possible to establish the proposed regional training centres. We would hope that the Boards might provide a timetable for their planned expansion of training since it is they who have most scope for improving the present situation. (7:41)

G. Recommendations for the Implementation of this Report

1. The authorities sponsoring this Committee should appoint as soon as possible a small continuing committee representative of the departments and the local highway authorities to foster progress. (15:12)

2. The secretariat of such a Committee might be placed with the Ministry of Transport. (15:12)

3. Special relationships should be developed between the departments and a few local authorities to provide a reference point for other authorities during the development period. (15:12)

4. The continuing committee should encourage regular liaison arrangements between the departments and major authorities on all aspects of maintenance. (15:12)

Appendix 1: Proposed Initial Standards of Maintenance

Introduction

1. There are no country-wide standards of maintenance, the standards adopted by highway authorities being generally ill-defined and varying according to the judgment of the responsible maintenance engineer and the funds available. We present in this Appendix the first set of defined maintenance standards devised for common use. They are labelled *initial* both because they are the first attempt to cover the whole field and because they will need continuing study and research to refine them.

2. In studying present maintenance standards the Road Research Laboratory tabulated the standards stated to be used by the highway authorities taking part, since little of this information had ever previously been listed or codified.

3. The initial standards were originally drawn up by the RRL's study team and are based on a detailed examination of present practice and Laboratory studies where available. They have now been critically examined not only by engineers from the Committee and the RRL but by many others. There are a few differences between our standards and some recommendations published by the RRL in other connections, for example on acceptable levels of skidding resistance.

4. The initial standards represent in many respects a material upgrading of present practices and will therefore have to be introduced gradually over a period of years. Even in the longer term some of them may not be easy to achieve, for example in areas lacking certain materials, but this should not lead to the acceptance of lower standards.

Differences from Present Practice

5. The total application of the new standards would raise the standards of structural maintenance above those commonly achieved. This reflects our belief that at present treatment is not always adequate to prevent road failure. The initial standards will indicate whether deterioration or failure are minor and can be arrested or whether they are so far advanced that reconstruction is needed. The expected life of different surface treatments has not been defined. Where appropriate, separate standards have been suggested for roads of differing importance; unless otherwise stated motorways are included with trunk roads.

6. Through lack of firm evidence on the effectiveness of different frequencies of inspection for many maintenance functions, we have adopted the mean of

current practice wherever this appears to be satisfactory. In some cases however, in particular road lighting, we have recommended less frequent inspections than are used by most authorities. Modern lighting installations are sufficiently reliable to make unnecessary the almost nightly scouting of their operation practised by some authorities. We have proposed the use of programmed maintenance, eg bulk changes and renewals at predetermined intervals, wherever applicable, to avoid piecemeal use of resources. The practice of asking the public to report road lighting failures is not recommended because a fixed replacement programme planned in conjunction with routine inspections achieves the object more efficiently.

7. A few highway authorities dispense with regular inspections on the grounds that their supervisory staff are constantly travelling around their areas and will themselves note any defects. Although all highway authority employees should report defects noted in the course of their work, such reports cannot take the place of carefully planned and properly recorded inspections covering the entire highway network.

8. The standards for amenity functions (grass cutting and sweeping) are intended to establish the level of basic highways need and are therefore somewhat lower than present practice. Any increase over the standards would clearly be for amenity reasons only.

9. We did not accept a suggestion that equipment and depots for snow and ice clearance on motorways should enable salting for snow to take place within one hour. Instead we have recommended a time limit of two hours, a standard attainable at present levels of equipment. We realise, however, that once it is decided to salt, the operation should be carried out as quickly as possible if snow clearing plant is not itself to be immobilised in traffic. For this reason we hope that one of the short-term studies we have recommended will be directed to establishing an economic standard for this function.

Role of Initial Standards

10. As stated above, the initial standards involve higher standards of structural maintenance than generally obtain at present and we do not envisage that authorities will fully achieve them for several years. In addition, conditions vary between highway authorities' areas and not everything can be codified. The initial standards should not therefore be applied rigidly but with discretion in the light of local requirements and conditions. However, before major departures are made, their implications should be thoroughly examined.

11. Although the precise economic effect of the proposed standards has not yet been assessed we believe that their adoption by highway authorities as the target of maintenance policy would have great advantages. One important and immediate role for these standards is to provide the basis for the maintenance rating system which we recommend and describe in Appendix 2. Without defined standards conditions cannot be recorded nor priorities assessed in the objective manner required for maintenance ratings. In addition a uniform

approach to standards by all authorities would itself aid empirical assessment and eventually the development of more objective standards. We therefore commend them to our sponsors both as the target to which authorities should direct their maintenance and as the basis for further research into their refinement.

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Structural Maintenance

1. Structural Maintenance of Bituminous Carriageways and Hardshoulders

1.1. SURFACE DRESSING

1.1.1. *The Object* is to seal porous surfaces against the entry of water, to bind surfaces at the onset of deterioration due to loss of stone etc, to delay further deterioration or to restore loss of skidding resistance (which may be due to loss of texture depth, polishing of the aggregate or fatting-up).

1.1.2. *Suggested Standards*

Surface dress when any one of the following conditions arises:—

(i) the surface appears to be generally open or finely crazed, or not impervious to water.

(ii) deterioration occurs over more than 10% of the wheel tracks in the near-side traffic lane or 5% of the whole carriageway surface.

(iii) the skidding resistance in terms of sideways force coefficient falls significantly below the figures given in the following Table:—

Categories of sites and suggested target values of skidding resistance

Category of Site	Type of Site	Skidding resistance	
		Test speed km/h (mph)	Sideways-force coefficient
A	Most difficult sites eg (i) roundabouts (ii) bends with radius less than 150m (500 ft) on unrestricted roads (iii) gradients of 5% (1 in 20) or steeper or longer than 100m (330 ft) (iv) approaches to traffic signals on unrestricted roads	50 (30)	0·55
B	Average sites eg (i) motorways and other high speed roads (ie speeds in excess of 95 km/h (60 mph)) (ii) trunk and principal roads and other roads with more than 2,000 vehicles per day in urban areas.	50 (30) 80 (50) 50 (30)	0·50 0·45 0·50
C	Other sites ie straight roads with easy gradients and curves, without junctions and free from any feature, such as mixed traffic, especially liable to create conditions of emergency.	50 (30)	0·40

Note 1: On heavily trafficked urban roads surface dressing may be technically or practically unacceptable. Where it can be done on heavily trafficked roads no more than three surface dressings should be applied before resurfacing though on lightly trafficked roads a greater number of surface dressings is acceptable. Where partial stripping, fatting-up or creep of the surface due to a large number of successive surface dressings has occurred, heating and planing may be necessary before surface dressing. Surface dressing of newly laid roads for sealing should not, of course, await the conditions described above.

Note 2: It is known that to achieve the above targets in some circumstances, eg certain Category A sites with very heavy traffic, requires very expensive treatment employing materials in short supply. Such expenditure may well be justified where accident rates are high. Elsewhere, until more factual information relating benefits to costs is available, judgment should be exercised in attempting to maintain high values of resistance to skidding.

1.2. PATCHING

1.2.1. *The Object* is to repair local areas of serious deformation, crazing and cracking, potholes, erosion and edge failure of carriageways and unsatisfactory trench reinstatements.

1.2.2. *Suggested Standards*

Patch:—

(i) as soon as discovered, ie within 24 hours if practicable, any pothole which forms in a trunk or principal road, or which on other roads puts the public at potential risk, eg potholes which could throw cyclists off their machines; and on any road as soon as possible if there is risk of further rapid deterioration.

(ii) when local areas of deterioration or deformation occur which show defects corresponding to those set out in para 1.3.2. (i)–(iii) below but which are so small or scattered as not to warrant complete treatment of the carriageway but are likely to extend if not treated. If the defects appear gradually they can be repaired on a programme basis but if they appear rapidly they should be repaired forthwith.

(iii) isolated areas where standing water, 6mm ($\frac{1}{4}$ in) deep, remains after rain has ceased on trunk and important principal roads.

(iv) edge erosion, as it occurs, as soon as practicable. If the erosion continues with old patches failing in the same maintenance season, consideration should be given to reconstruction of the edge.

(v) failures of permanent trench reinstatements as they appear, treated as (i) or (ii) above. In the case of temporary reinstatements, the statutory undertaker should be instructed to take action within the appropriate time limits, but if the public is potentially at risk and the statutory undertaker fails to take immediate action, the highway authority should take the necessary action as soon as possible at the statutory undertaker's expense and without relieving him of his legal liability.

Note: The need for extensive patching is an indication of the onset of general failure of the pavement. In that case resurfacing or reconstruction should be considered, since patching is a comparatively expensive method of repair and only a local cure involving abortive expenditure when followed within a short time by resurfacing.

1.3. RESURFACING AND RECONSTRUCTION

1.3.1. *The Object* is to correct general deterioration of the surface, deformation, structural failure, surface irregularity, unsatisfactory camber or cross-fall and, under certain circumstances where surface dressing is inappropriate, the loss of skidding resistance, and to strengthen the pavement in anticipation of structural failure in the near future due to traffic loads.

1.3.2. *Suggested Standards*

Resurface when any one of the following conditions arises:—

(i) cracking covers more than 30% of the wheel tracks in the near-side traffic lanes over the length showing failure in the case of trunk, principal and important non-principal roads, and 50% in the case of other roads.

(ii) the permanent deformation measured across the near-side wheel tracks of the near-side traffic lanes is in the order of 13 mm under a 2 m straight edge (0·5 in under a 6 ft straight edge) over more than 20% of the length showing deformation in the case of trunk, principal and important non-principal roads.

(iii) general deterioration of the surface (loss of aggregate from the surface, fine crazing, etc) covers more than 20% of the whole carriageway surfacing over the length showing failure.

(iv) surface irregularity indicated by the bump integrator (r values) reaches the following values in the near-side traffic lanes:—

trunk and important principal roads—	180–220 inches per mile
other principal roads and important non-principal roads—	200–240 inches per mile.

The first figure for each category indicates the normal maximum acceptable r value and the second figure the permissible maximum; above this value resurfacing should be undertaken.

(v) the skidding resistance falls significantly below the figures in the Table in para 1.1.2. (iii) above.

(vi) the camber or the adverse camber at bends is so excessive as to be potentially dangerous, or the cross-fall is inadequate to provide run-off of surface water, causing water to remain on the carriageway to a potentially dangerous extent. Normally, however, unsatisfactory camber or cross-fall alone would not be sufficient to justify resurfacing or reconstruction but would be regarded as contributory factors.

1.3.3. *Comments on Resurfacing*

(i) Resurfacing in rural areas would not normally be carried out in lengths much less than about 500 m or $\frac{1}{4}$ mile. For inspection purposes it would therefore seem convenient to consider the percentage deterioration etc over 500 m or $\frac{1}{4}$ mile sections. In urban areas resurfacing has to take account of the level of the carriageway in relation to that of adjoining properties. Heating and planing can be used or local reconstruction may have to be carried out instead, in which case shorter lengths could be considered. It may also be convenient to consider lengths of road between junctions rather than sections of a given length. The problem of levels would also be present in rural areas but to a much lesser extent.

(ii) Anticipating the need for treatment and determining the minimum thickness of material to be added are best done using either the Deflection Beam or the Deflectograph, but where neither is available they must be based upon experience and judgment, using the deformation criteria given.

(iii) When deciding upon the thickness of material to be added, the most economical solution will depend upon a number of factors. These are: the transient deflection measurements obtained from the Deflection Beam or the Deflectograph (or if not available, the amount of deterioration), the anticipated future traffic loading in terms of the cumulative total of commercial vehicles, the existing construction of the carriageway and the

immediate and future resurfacing costs. In some cases, it may be more economic to use *stage construction* or to resurface before the deformation reaches the extent described in para 1.3.2.

(iv) When resurfacing is being carried out to correct for loss of skidding resistance alone, the minimum thickness at which the material could be laid would be sufficient, but it might be economic to take the opportunity to increase the strength of the carriageway at the same time by adding a greater thickness (see (iii) above).

(v) If the deterioration or deformation has progressed much beyond the criteria given in para 1.3.2. (i) and (ii) above, eg obvious failure including area cracking, permanent deformation in excess of 18 mm under a 2 m straight edge (0·7 in under a 6 ft straight edge), over 20% of the length showing deformation, reconstruction would be necessary or alternatively, where levels permit, the addition of a considerable thickness of material.

(vi) Other possible causes of deterioration and deformation (particularly when severe) other than inadequate strength and excessive traffic, eg inadequate or poorly-maintained drainage, should always be sought and, if present, cured.

1.4. INSPECTIONS, MEASUREMENTS OF CONDITION AND TESTS

1.4.1. *Routine Inspections*

(i) Suggested frequencies for programmed inspections of rural and urban highways are given below. Though the main items to be inspected are the carriageway and hardshoulder (if any) for patching, the condition of footways, kerbs, carriageway markings, verges, slopes, structures, street furniture etc should also be recorded in the inspectors' reports, which should include details of the inspections made. Action taken later should also be recorded.

(ii) Inspectors should be informed of lengths of road or areas which require particularly careful inspection. These could include surface dressings and medium and open-textured carpets which have lasted more than 5 years since the last surface treatment, known weak areas, known accident spots etc. Their reports should include specific mention of such lengths and areas.

(iii) It will probably be impractical on these inspections to carry out measurements of defective areas for the conditions set out in para 1.3.2. (i) (ii) and (iii) above. Areas needing measurement should therefore be noted for further visits.

(iv) It is important to take account of the fact that inspections of the roads' structural condition are likely to take place many months before treatment is carried out. The conditions set out in paragraphs 1.1.2. and 1.3.2. are those requiring immediate treatment. The deterioration that will occur during the period between inspection and treatment should therefore be anticipated and allowed for.

(v) Suggested frequencies of inspection for roads in rural highway authorities' areas are:—

trunk and important principal roads—	once per month
other principal and important non-principal roads—	every two months
other non-principal roads—	every six months
roads in villages and shopping areas—	once to twice per month according to importance
roads in residential areas—	every two or three months.

(vi) For roads in urban highway authorities' areas frequencies should be:—

trunk and principal roads and main shopping areas—	twice per month
other roads in town centres and less important shopping areas—	once per month
other roads—	every two to three months.

1.4.2. *Special Inspections, Measurements and Tests*

Apart from the routine inspections discussed above the following special inspections, measurements and tests should be carried out:—

(i) measurement of any special defects found as a result of the routine inspections.

(ii) special inspection of roads known to be liable to damage as soon as possible after periods of severe frost or flooding.

(iii) measurements for surface irregularity on trunk, principal and important non-principal roads with a bump integrator. These should be taken every 5 years or every year when the r value has risen above the lower value given in para 1.3.2. (iv) above or if it is suspected on inspection of having risen above this value.

(iv) skidding resistance tests—when SCRIM is generally available for the rapid measurement of skidding resistance, all trunk and important principal roads should be tested as matter of routine at least annually as should also special danger areas, eg junctions controlled by traffic lights or sharp bends, and known accident spots on other roads.

(v) where the acceptable limit of deformation given in para 1.3.2. (ii) above is being approached or has been exceeded, the Deflection Beam can be used to determine the required thickness of material to be added. In due course the mobile version of this instrument—the Deflectograph—may become available for the routine survey of existing roads and this will help to anticipate failure. It is hoped that such surveys could be made at intervals of about 5 years on all trunk and important principal roads depending on experience of the new apparatus.

2. Structural Maintenance of Concrete Carriageways and Hardshoulders

2.1. PATCHING

2.1.1. *The Object* is to repair spalling of the surface and at joint faces and unsatisfactory trench reinstatements.

2.1.2. *Suggested Standards*

Patch when:—

(i) general spalling of the carriageway exceeds about 5% of the area per 500 m section or appropriate length in the case of urban roads, or individual areas exceeding 5 m^2 (50 ft^2) and 10 mm ($\frac{3}{8}$ in) in depth.

(ii) spalling at transverse or longitudinal joints exceeds about 5% of the length of both joint faces over all joints in each 75 m (240 ft) of carriageway or when any individual spalled length exceeds 700 mm (2 ft).

(iii) any spalling which could put the public at risk should be repaired as soon as discovered, ie within 24 hours if practicable, if necessary on a temporary basis using a bituminous material.

(iv) spalling on trench reinstatements made in concrete should be treated as in (i), (ii) and (iii) above. Failures of trench reinstatements made in bituminous materials should be treated as in para 1.2.2. (v) above.

2.2. RESURFACING AND RECONSTRUCTION

2.2.1. *The Object*

Concrete roads do not usually require resurfacing in the same way as bituminous roads but they may require overall treatment if the amount of surface spalling is such as would be uneconomic to correct by patching. Reconstruction or overall treatment (overslabbing with concrete or overlaying with bituminous materials) is carried out to correct structural failure and surface irregularity.

2.2.2. *Suggested Standards*

Reconstruct, overslab or overlay when:—

(i) the total length of all transverse cracking in reinforced slabs (from hair to wide cracks) exceeds 75 m (250 ft) per 30 m (100 ft) of traffic lane. Any transverse cracking in unreinforced slabs, however fine, is an indication of failure, probably needing reconstruction.

(ii) the average difference in level over the length of transverse joints exceeds 6 mm ($\frac{1}{4}$ in) on 50% of the joints per 75 m (240 ft) length of carriageway.

(iii) the surface irregularity falls below the standards given in para 1.3.2. (iv) above.

2.2.3. *Comments on Resurfacing*

(i) Whether reconstruction or overall treatment should be used would depend, amongst other factors, upon the number and location of failed slabs. The decision should be made after an economic assessment. Where cracking is confined mainly to a few wide cracks, it may be preferable to convert these into transverse joints, either expansion or contraction. It may even be preferable to reconstruct only a portion of a slab. Again the economics should be studied.

(ii) Although these standards are applicable to all concrete roads, whatever the traffic loading, a lower standard can be applied to lightly trafficked roads, eg housing estate roads, not constructed to current design recommendations.

2.3. OTHER FORMS OF MAINTENANCE

2.3.2. *The Object*

Other forms of maintenance required by concrete roads are correction of loss of skidding resistance, resealing of joints to prevent entry of stones and grit, prevention of vertical movement of the slab (which causes mud pumping) and repair of longitudinal cracks.

2.3.3. *Suggested Standards and Treatment for Skidding*

Overall treatment should be given when the skidding resistance falls significantly below the figures given in the Table in para 1.1.2. (ii) above. The form of treatment may be:—

(i) grooving by sawn or other approved technique.
(ii) surface dressing—this has hitherto not been generally recommended for heavily trafficked concrete roads but with improved materials and techniques it can give satisfactory results.
(iii) over-slabbing with concrete or overlaying with bituminous materials.

2.3.4. *Suggested Standards for Joint Resealing*

(i) Transverse joints on trunk and important principal roads should be resealed on a programme basis, every 4 years where hot-poured sealants are used and every 10 years with cold-poured sealants. All joints should be treated irrespective of condition. Individual joints should only be treated when small stones and grit are accumulating in the joint to such an extent that spalling at the edges is likely to occur or when there is a complete loss of sealant over 20% of the joint length, per lane width. On other roads, resealing of transverse joints should be carried out only on a needs basis, as defined above for individual joints on trunk and principal roads.
(ii) Longitudinal joints are unlikely to require resealing, but the same criteria of individual need can be applied to them as to transverse joints.

2.3.5. *Suggested Standards for Vertical Movement of Slabs*

As soon as vertical movement is detected, (mainly by the occurrence of mud-pumping), the cause should be investigated and remedial works carried out. These may be improvements to sub-soil drainage, resealing of joints, sealing of cracks etc to prevent entry of water. In some cases, local reconstruction of the slab and base may be required. Pressure grouting is likely to provide only a temporary cure unless allied to improved drainage and sealing.

2.3.6. *Suggested Standards for Repair of Longitudinal Cracking*

Where the cracks do not occur over the transverse tie bars at the longitudinal joints, they should be repaired by the insertion of tie bars as soon as they are discovered and the cause of the cracking investigated. Cracks near the longitudinal joints, ie over the tie bars, should be sealed.

2.4. INSPECTIONS, MEASUREMENTS OF CONDITION AND TESTS

2.4.1. *Routine Inspections*

These should be made at the same frequency and for the same general purposes as those for bituminous roads, shown in para 1.4.1. above.

2.4.2. *Special Inspections, Measurements and Tests*

All concrete pavements on trunk and important principal roads should be inspected once per year on foot for cracks and serious cases of joint sealant failure, since these are not likely to be revealed on routine inspection carried out from a moving vehicle. Other special inspections, measurements and tests should be carried out as indicated for bituminous roads in para 1.4.2. (i)–(iv). It should be noted that in Great Britain the Deflection Beam is not normally considered to be suitable for use on concrete roads.

3. Maintenance of Footways

3.1. *The Object* is to provide a reasonably safe path for pedestrians both by day and by night.

3.2. RURAL FOOTWAYS

3.2.1. *Suggested Standards*

Potentially dangerous conditions should be repaired or signed as soon as they are reported, otherwise only the minimum of maintenance to keep them safe and free of standing water should be carried out.

3.2.2. *Inspections*

These should be carried out when carriageways are inspected and in any case not less than:—

(i) village footways—monthly
(ii) other footways—twice per year.

3.3. URBAN FOOTWAYS

3.3.1. *Suggested Standards*

Potentially dangerous conditions should be repaired or signed as soon as they are reported. Otherwise, for shopping areas and town centres, there should be an annual programme of patching and resurfacing to keep the surface even and free of loose material and standing water. In outer areas, the minimum of maintenance only, to keep them safe and free of standing water, should be carried out.

Note: It is difficult to define dangerous conditions as these are liable to vary according to circumstances and legal interpretations. However, we suggest that urban footways in which the following conditions occur should be dealt with to prevent further deterioration and the likelihood of dangerous conditions arising:—

projections and sharp edges more than 20 mm ($\frac{3}{4}$ in) high,
cracks or gaps between flags more than 20 mm ($\frac{3}{4}$ in) wide,
rocking slabs,
depressions more than 25 mm (1 in) deep,
loose stones on hard surfaces.

We consider that new footways should generally be constructed with bituminous materials, including mastic or hot rolled asphalt where very heavy wear is

expected, because they will be less likely to give rise to the above conditions and easier to maintain. Concrete and stone flags should be used only in special cases.

3.3.2. *Inspections*

Suggested frequencies are:—

(i)	in main shopping areas—	twice per month
(ii)	in lesser shopping areas and other footways in inner areas—	once per month
(iii)	in outer areas—	every two to three months.

Note: In addition to the recommended inspections, footway sweepers should report any defects seen in the course of their duty.

4. Gully Emptying and Maintenance of Drainage Systems

4.1. *The Object* is to ensure that surface water is removed from the carriageway as quickly as possible and not allowed to penetrate to the foundations of the road.

4.2. SUGGESTED STANDARDS

4.2.1. *Gully emptying*

The frequency of gully emptying depends to some extent upon local conditions and the presence of dirty industries. In general in the absence of a specific measure of need the minimum suggested frequency is three times a year for all roads, though in some rural areas it may be possible to reduce the frequency to as little as once per year.

4.2.2. *Drainage systems*

These should be checked twice a year, before and after the winter, to ensure that they are functioning properly. In areas where leaves tend to accumulate additional inspections should be made during the autumn, their frequency to be based on experience. In addition, all trunk and principal roads and other roads if possible should be inspected at least once a year during periods of heavy rain, to ensure that under one-year storm conditions the following standards are being achieved:—

(i) *trunk and principal roads*—no water running in the side channels more than 600 mm (2 ft) out from the edge of the carriageway while rain is falling, nor any standing water in the channels extending more than 600 mm (2 ft) out from the edge of the carriageway after rain has ceased. Also, there should be no concentrated flow of water across carriageways from one side-channel to the other (excluding the normal distributed flow across dual carriageways with a constant cross-fall).

(ii) *important non-principal roads*—no standing water in the channels extending more than 600 mm (2 ft) from the edge of the carriageway after rain has ceased.

(iii) *other roads*—no standing water extending more than 1 m (3 ft) from the edges of the carriageway, after rain has ceased.

5. Maintenance of Kerbs

5.1. *The Object* is to protect pedestrians, to provide water channels, to lead surface water into gullies and to define and support the edge of the carriageway, eg in order to prevent over-riding, where other means are unsuitable.

5.2. New kerbing should be provided where footways are less than 1·20 m (4 ft) from the edge of the carriageway; or where a special need exists either to provide free flowing water channels at the edge of the carriageway or to define the edge of the carriageway, eg on roads with serious over-riding or heavy night traffic, where it is impracticable to do so by other means.

5.3. SUGGESTED STANDARDS

5.3.1. *Rural roads:—*

(i) with no footways or infrequently used footways within 1·20 m (4 ft) of the carriageway:
  (a) replace defective kerbing in the annual programme;
  (b) lengths of kerbing which have sunk should be raised where the upstand is less than 25 mm (1 in).

(ii) with frequently used footways within 1·20 m (4 ft) of the carriageway:—
  (a) defective kerbing as above;
  (b) kerbing which has sunk should be raised where the upstand is less than 75 mm (3 in).

5.3.2. *Urban roads with footways:—*

(i) replace defective kerbing when reported if potentially dangerous to pedestrians, otherwise in the annual programme;

(ii) kerbing which has sunk should be raised where the upstand is less than 75 mm (3 in).

Where upstanding kerbs are installed or renewed, the maximum possible upstand, but not exceeding 175 mm (7 in) should be provided, primarily to allow for future resurfacings, to protect pedestrians and to prevent over-riding.

6. Maintenance of Bridges, Culverts and Other Structures

6.1. *The Object* is to maintain all bridges, culverts and other structures so that:—

(i) the safety of road users will not be jeopardised;

(ii) deterioration leading to a reduction in life of the structure or expensive repair work is prevented.

6.2. SUGGESTED STANDARDS

All structural members, bearings and expansion joints must normally be maintained so that their continued performance in service without loss of safety and efficiency is ensured. However, where a bridge or culvert is programmed for renewal, only the minimum of maintenance consistent with safety should be carried out. Iron and steel work of bridges and culverts should be painted in a periodic programme, the frequency of which will be determined by local conditions and the results of annual inspections.

6.3. INSPECTIONS

6.3.1. *Bridges and culverts*

(i) The frequency of inspection will depend upon the form of construction, age, general condition and other special considerations but should not normally be less than once per year. Foundation inspections should be included with those of the structure and where applicable should include underwater inspections.

(ii) More frequent inspections will be required for bridges and culverts in areas of mining subsidence and those crossing rivers liable to sudden flooding. Bridges crossing heavily trafficked waterways must be inspected frequently (up to daily if necessary, though by non-technical staff) to check for signs of collisions by vessels on the waterway. The moving parts of bridges, eg expansion joints and bearings, may need to be inspected two or three times a year depending on the range of movement and type of construction. Moving bridges and major structures deserve a special inspection and maintenance programme which will depend on the size and complexity of the structure. These are not dealt with further as they are relatively few and need to be considered individually.

(iii) Bridge inspections should as far as possible be carried out by an engineer experienced in bridge work. Where technicians are employed on these inspections, they should be provided with detailed schedules to ensure adequacy and consistency of inspections. Old and known weak bridges and culverts should always be inspected by a bridge engineer. So too should all cases of serious damage or deterioration.

6.3.2. *Other structures*

Generally the frequency and method of inspection should follow the conditions suggested for bridges and culverts. They should also be inspected superficially during routine highway inspections.

7. **Maintenance of Embankments and Sides of Cuttings**

7.1. *The Object* is to preserve stability of slopes and rock cuttings and to prevent damage by erosion. The sides of deep ditches should also be included under the general term of slopes.

7.2. SUGGESTED STANDARDS OF INSPECTION

(i) All slopes and rock cuttings should be inspected annually, preferably in the spring, for incipient slides, falls, failures amd signs of erosion by surface water or springs, but more frequently if trouble is suspected. They should also be inspected superficially during other routine highway inspections. Any necessary remedial action should be taken as soon as practicable.

(ii) Any slopes etc not owned by the highway authority but the failure of which might cause danger to road users should be included in all inspections. If potentially dangerous conditions are found, the owner or occupier of the land should be informed and requested to take the necessary action.

8. Siding and Verge Maintenance

8.1. *The Object* is to prevent the encroachment of verge soil and growth on to the carriageway and to maintain verges in a condition which allows the cutting of grass without damage to the machines.

8.2. STANDARDS SUGGESTED

(i) *Siding.* In rural areas only the minimum amount of siding should be carried out, for example when needed before surface dressing and renewal of edge markings, since in most cases traffic keeps the carriageway clear. Siding is not normally required in urban areas since most roads have upstanding kerbs.

(ii) *Verge maintenance.* This should be carried out only on a needs basis as determined by inspection. The need is likely to be greater in urban than in rural areas due to the parking of vehicles on the verges of residential roads.

Aids to Movement and Safety

9. Snow and Ice Clearance

9.1. *The Object* is to prevent or reduce the effects of adverse weather conditions on the movement of traffic, so that it can circulate in safety on the more important parts of the road network. Ideally the aim should be to maintain bare wet surfaces on all important roads all the time.

9.2. SUGGESTED STANDARDS

9.2.1. *Motorways and very important trunk roads*

(i) 24 hour availability of equipment crews and, in principle, pre-salting on receipt of snow and frost warnings. Access routes to motorways whatever their class should be given the same treatment and priority as motorways.

(ii) Equipment and depots should be sufficient to salt for snow all roads in this group in 2 hours.

(iii) Snow clearing equipment requirements must be judged on local conditions, experience and the likely effectiveness of pre-salting. Motorways and very important trunk roads should never become impassable to heavy vehicle traffic unless there are exceptional weather conditions and when snow is drifting.

9.2.2. *Other roads*

(i) The remainder of the road network should be grouped as follows for priorities and standards:—

Priority 1—remaining trunk roads and important principal roads, together with access routes to hospitals, fire stations etc, and special danger spots such as bridges or steep hills (particularly applicable to urban roads).

Priority 2—public service bus routes not included in Priority 1 and the remaining principal roads.

Priority 3—access to isolated villages and hamlets together with main food supply routes.

Priority 4—remaining roads.

Some modification may be required in urban areas to give high priority to heavily-used commuter routes and access to large factories, offices and other centres of high employment.

(ii) Standards must depend to some extent on local conditions and climate but the minimum standard suggested is in principle pre-salting on Priority 1 and 2 routes on receipt of snow or frost warnings, but subject to judgment and local experience, and salting of Priority 3 routes later, if adverse conditions become apparent. (Salting for light frost on these routes is probably unnecessary). Priority 4 routes should not normally be treated unless conditions are severe and likely to persist for several days (and provided resources are available after treating the higher priority routes). Snow clearance should be started as soon as practicable and the need for it becomes apparent, beginning with Priority 1 routes and then Priorities 2 and 3 as they become accessible and equipment is available.

(iii) Equipment and depots provided should be sufficient to salt for snow all Priority 1 and 2 roads in 2 hours, though the aim should be to salt important urban roads within 1 hour if at all possible.

(iv) Snow clearing equipment requirements must again be judged on experience, but with the following criteria as a guide. No Priority 1 road should remain impassable to heavy vehicle traffic for more than 6 hours in rural areas or 4 hours in urban areas except under exceptional weather conditions and when snow is drifting. In urban areas this standard may also need to be applied to Priority 2 roads. Equipment should enable Priority 2 and 3 roads to be made passable to heavy vehicles within 24 hours and 48 hours respectively under similar circumstances.

9.2.3. *Footways*

Any surplus labour available due to closing down of normal works should be used to clear dangerous lengths of footways in special areas, eg town centre, steep hills. In areas where there is a heavy concentration of pedestrians, footways should be dealt with at the earliest possible moment and gaps formed in piled snow at roadsides at bus stops and crossing points.

9.3. SALTING AND GRITTING

Neat salt only, complying with B.S. 3247: 1960[14], should be used on motorways etc and on Priority 1 and 2 roads, although in some circumstances salt/grit mixtures may be preferable, (see Road Note 18[15]).

9.4. COMMUNICATIONS

All highway authority owned snow clearing vehicles should be equipped with radio telephones. During working hours it should be possible to contact all

drivers needed for snow and ice clearance, preferably direct by radio telephone, but otherwise within half an hour. All personnel liable to call-out from their homes should be provided with telephones.

9.5. PLAN

There should be a comprehensive detailed plan for dealing with snow and ice conditions. It should include instructions on:—

a. who is responsible for ordering action and when;
b. the different priorities and the routes to be followed when treating them, with detailed lane routes for large roundabouts and junctions;
c. whether difficult routes should be closed to selected classes of vehicles and how this is arranged;
d. action necessary to centralise control of all resources in the event of emergency conditions;
e. minimum stores of salt to be maintained;
f. any special action required on thaw after snow;
g. erection and dismantling of snow fences.

In preparing the plan consideration must be given to the statutory limitations on hours of driving and to the possibility of drivers having consumed excess alcohol shortly before call-out.

10. Maintenance of Road Markings and Reflecting Studs

10.1. *The Object* is to define carriageway lanes and edges, warnings, parking and waiting restrictions and to convey *give way* and other instructions to road users in a manner clearly visible both by day and by night.

10.2. SUGGESTED STANDARDS OF RENEWAL AND REPLACEMENT

(i) All mandatory markings existing before resurfacing or surface dressing should either be masked during treatment or replaced within one week of completion of the work.
(ii) Other markings and reflecting studs should be replaced as soon as economically possible and practicable after completion of the surfacing work.
(iii) Reflecting studs should be replaced as soon as they become ineffective or loose. Otherwise they should be replaced on a bulk change system at the end of their average effective life.
(iv) Road markings should be renewed when more than approximately 20% of their area becomes worn away or ineffective.

10.3. INSPECTIONS

Road markings and reflecting studs should be inspected once a year by night before winter for visibility and any special renewals. They should also be checked during periodic carriageway inspections by day. One of the inspections should be timed for the early spring to detect any damage caused by snow clearance operations.

11. Maintenance of Traffic Signs (excluding Road Markings) and Bollards

Note: Technical guidance on the maintenance of signs is given in the Traffic Signs Manual, Chapter 11, Section 8, *Illuminated Signs* and Chapter 12, *General Guidance*[16].

11.1. *The Object* is to keep all traffic signs legible and visible as far as possible at all times, in relation to road use and traffic speeds.

11.2. SUGGESTED STANDARDS

Note: Stop and give-way signs on minor roads should be included in the inspections of signs on the major roads to which they control entry.

11.2.1. *Illuminated signs*

(i) scouting for illumination—	weekly
(ii) lamp changing—	bulk changing at nominal life and individually on failure
(iii) internal inspections and cleaning—	at least once per year
(iv) external cleaning—	at least 3 times per year but more frequently if necessary especially for bollards
(v) replacement and repair of damaged signs and bollards—	as soon as possible after damage reported (bollards and stop signs within 24 hours)
(vi) painting of supports and frames—	as required (condition reported when cleaned).

11.2.2. *Non-illuminated signs*

(i) general condition—	inspect once per year by night after cleaning
(ii) cleaning	
(a) *trunk, principal and important non-principal roads*—	at least 3 times per year but more frequently if necessary
(b) *other roads*—	stop and give-way signs at least 3 times per year; other signs at least once per year
(iii) replacement and repair of damaged signs—	as soon as possible after damage reported (stop signs within 24 hours)
(iv) painting of signs, supports and frames—	as required (condition reported when cleaned).

12. Maintenance of Traffic Signals

12.1. *The Object* is to keep the signals in correct operation at all times.

12.2. SUGGESTED STANDARDS

(i)	scouting for illumination—	include with road lighting (Section 14) but all highway department personnel should report faults as soon as discovered
(ii)	lamp changing—	at maker's guarantee and immediately on failure being notified
(iii)	internal inspection, maintenance as necessary and cleaning—	every 3 months
(iv)	checking of phasing—	every 3 months
(v)	checking of alignment—	every 3 months
(vi)	mechanism—	on-call contract with suppliers
(vii)	external cleaning—	as necessary but at least 4 times per year
(viii)	post painting—	as required (condition reported when cleaned).

13. Maintenance of Pedestrian Crossings

13.1. *The Object* is to indicate the presence of the crossing at all times.

13.2 SUGGESTED STANDARDS

(i)	*Beacons*—	as for traffic signals except for flashing mechanism which should be replaced immediately failure is notified
(ii)	*Road markings*—	include with carriageway inspections. If slipperyness is suspected they should be tested with the portable skidding resistance tester. A minimum figure of 55 is recommended. Markings should be renewed if they are 20% worn.

14. Maintenance of Road Lighting

14.1. *The Object* is to maintain the designed standard of illumination with a reasonable degree of certainty.

14.2. SUGGESTED STANDARDS

(i)	scouting for illumination—	weekly
(ii)	lamp changing—	bulk changing at nominal life and individually on failure, though replacements should not be undertaken more frequently than the scouting frequency.

(iii)	lantern internal inspection and cleaning—	at least once a year
(iv)	lantern external cleaning—	at least twice per year
(v)	column painting—	as required (condition reported during inspection).

Note: The standards suggested above are subject to review as new and improved lighting is installed.

15. Maintenance of Guard Rails and Safety and Boundary Fences

15.1. *The Object* is to maintain them in a sufficiently sound structural condition to serve their function and not to be dangerous to road users or pedestrians.

15.2. SUGGESTED STANDARDS

(i)	condition—	inspect with routine carriageway and footway inspections and repair or replace as soon as possible after damage is reported. If the public is at risk, repair within 24 hours.
(ii)	painting—	if and as required (condition reported when inspected)
(iii)	cleaning—	after winter salting has ceased and as necessary, particularly for pedestrian guard rails (condition reported when inspected). This will not usually be applicable to boundary fences.

Amenity Functions

16. Grass, Tree and Hedge Cutting

16.1. *The Object* is to prevent obstruction of sight lines at bends and traffic signs, to inhibit the growth of injurious and other weeds, (in accordance with the Weeds Act, 1959), to maintain a tidy appearance and, in the case of trees adjoining roads, to prevent them becoming a danger to road users.

16.2 FACTORS AFFECTING STANDARDS FOR GRASS CUTTING

Grass cutting is largely non-productive and only in preserving visibility of signs and at bends does it contribute to the safe utilisation of the highway. It should therefore be kept to the minimum compatible with legal requirements, public demand and the type of locality. This is of course in line with the wishes of nature conservancy organisations which regard road-side verges and hedges as an important habitat of wild-life. Serious infestations of injurious and other weeds can often best be dealt with by digging out or the controlled use of chemical sprays. The latter should however be used with great care.

16.3. SUGGESTED STANDARDS FOR GRASS CUTTING

16.3.1. *Rural Roads*

(i) Motorways and trunk roads—on the first 2 m (6 ft) of verges and on central reserves, grass should be kept below 150 mm (6 ins) and elsewhere on the roadside below 300 mm (12 ins).

(ii) Other roads—the minimum suggested is one cut the width of one pass of the mower per year plus additional cuts as necessary to maintain visibility at bends. On more important roads and on roads with well-used footways, more frequent and wider cuts (including up to full width every second year) may be considered necessary. Steep banks starting from the edge of the carriageway should be cut more frequently to avoid reducing the effective width of the carriageway or obstructing pedestrians.

16.3.2. *Urban Roads*

(i) Motorways and trunk roads—all grass should be kept down to 75 mm (3 ins).

(ii) Other roads—for highway purposes the same standards as for rural roads should apply.

Note: Where the standards above are expressed in terms of frequency of cut, they are based upon the use of motor scythes. The frequency to be adopted by authorities must of course be suited to the type of machine they use.

16.4. SUGGESTED STANDARDS FOR HEDGE TRIMMING

Where it is the responsibility of the highway authority, hedge trimming once a year should be sufficient on rural roads but is needed more frequently in urban areas. Where there is a special requirement, eg to preserve visibility at bends or across central reserves, cutting should be as required.

16.5. CHEMICAL SPRAYS

It may be necessary to use chemical sprays to eliminate weeds and control growth around posts carrying signs, along guard rails, on the edges of kerbs and on footways. They may also be used to control the growth of grass on the strip adjoining the edge of the carriageway and on central reservations. The use should be the minimum compatible with the required results.

16.6. TREES ADJOINING ROADS

All trees adjoining roads, whether owned by the highway authority or not, should be examined for potentially dangerous conditions during the periodic inspections detailed in para 1.4.1. In the case of trees owned by the highway authority any necessary corrective measures should be taken as soon as is reasonably possible. In the case of privately owned trees, the owner or occupier of the land should be warned of any danger and requested to take the necessary action.

17. Sweeping and Cleansing

17.1. *The Object* from the highways point of view is mainly to remove debris from the side channels, to prevent surface water ponding in them and an excess of detritus being washed down into gully pots and to keep the carriageway surface generally clean so that road markings are visible and windscreens not obscured by dirty spray.

17.2. SUGGESTED STANDARDS

Note: The following standards assume that sweeping is only really necessary on kerbed roads or where there are edge markings.

17.2.1. *Carriageways in rural areas*

(i)	important trunk roads—	monthly
(ii)	other trunk roads and principal roads—	every 2 months
(iii)	important non-principal roads—	every 3 months
(iv)	other roads—	every 6 months or less.

Standards must to some extent depend on local conditions and more frequent sweeping may be necessary at lay-bys, frequently used stopping places and in areas where dirty industries, eg coal mining or quarrying, are located and channels quickly become blocked. Sweeping on unkerbed roads may also be necessary under similar circumstances. In addition, on motorways and other heavily trafficked high speed roads, more frequent scavenging for objects in the carriageways, dangerous to road users, may be necessary.

17.2.2. *Carriageways in urban areas*

Higher standards will normally be required to cover both highway and cleansing needs:—

(i)	town centres and shopping areas—	daily
(ii)	other main roads—	2 or 3 times per week
(iii)	villages and residential areas—	every 1 to 3 weeks according to the density of development.

17.2.3. *Footways*

In urban and built-up areas, footways should be swept at the same frequency as the carriageways. Inter-village footways should not be swept.

Appendix 2: Maintenance Rating System

Introduction

1. Most highway authorities already have an informal and simple rating system in that roads are assessed for condition and possible forms of treatment, both improvement and maintenance, during travel over the road systems by engineering staff in the normal course of their duties. Closer consideration is then given to those lengths rated as in need of attention to determine priorities and programmes of work.

2. We believe that assessments should be formalised by systematic inspection and by evaluating the condition or adequacy of roads in numerical terms based on prescribed standards. This would enable priorities to be established objectively.

3. Our proposals are based on sufficiency rating systems which originated and are widely used in the USA. These are for the most part improvement-biased systems in which the maintenance aspect forms only a small part of the assessment and which are therefore inadequate for the purpose of formulating detailed annual maintenance programmes.

4. We believe that there is a need for a rating system specifically designed for highway maintenance. It could be used in isolation but would be more effective if used in conjunction with an improvement rating system. This would enable maintenance and improvement work to be programmed efficiently and to be integrated when the combined use of the two ratings showed this to be advantageous.

5. This Appendix sets out the requirements of a maintenance rating system and one way in which it could be set up. Other ways are possible but we believe that the general principles of the system described meet all the requirements and that development should be continued along the lines indicated. The details still need to be developed, preferably centrally, so that a uniform system can be adopted throughout the country, especially for trunk roads.

Object and Requirements of a Maintenance Rating System

Object

6. The principal aim is objectively to determine priorities so that areas of the greatest maintenance need can be identified uninfluenced by geographical or political considerations. First the condition and needs of defined lengths of road are assessed, using common standards, by detailed, methodical inspection and

are recorded by the allocation of points. The points and other factors based upon the characteristics of different lengths of road enable priorities to be established, on a measured basis, for the different maintenance needs within defined lengths of road and between different lengths of road.

Suggested requirements and explanatory comments

7. a. *Requirement*

The system should be related to the prescribed maintenance standards.

Comments

The set of initial standards set out in Appendix 1 shows when remedial action is desirable. Some of the standards, eg carriageway deformation, skidding resistance and surface irregularity, are given in a form which allows direct measurement of the actual condition. Others, eg footway conditions, must be judged subjectively.

b. *Requirement*

It should indicate when action is necessary by means of critical levels in the assessment, and, in appropriate cases, what action.

Comments

Each maintenance characteristic included in the system should be assessed separately. Points should be allocated either in respect of the road's overall condition or in respect of each major fault, any of which, when sufficiently developed, will call for treatment. The points system should indicate in each case if a critical level of deterioration has been reached. It should also indicate, where appropriate, the type of treatment required to remedy the defect.

c. *Requirement*

The system should be able to indicate priorities between different maintenance needs within individual lengths of road.

Comments

Some individual maintenance needs are more pressing than others. The critical levels referred to in (b) will not indicate this. To do so it is necessary to give more weight to some needs than to others. This would be done by applying weighting factors to the points allocated during the field assessment. These weighting factors would be based on the importance of the various needs in relation to the need to maintain roads in a structurally sound condition and to enable traffic and pedestrians to move safely, comfortably and expeditiously. The correct assessment of these weighting factors is vital to the effectiveness of the priority system. Sufficiency rating systems do not normally consider individual needs separately; points are totalled. This is not recommended for the maintenance rating since one urgent individual need may be hidden by near-perfection of all other needs.

d. *Requirement*

The system should be able to indicate priorities between different lengths of road taking into account their traffic flow as well as their physical condition.

Comments

Priorities should be established by grouping roads in terms of traffic flows, allocating weighting factors related to the volume of traffic and applying the same traffic weighting factor to all roads within each traffic group, irrespective of existing classification.

e. *Requirement*

It should be applicable, with modifications if necessary, to both rural and urban roads.

Comments

The system should be able to distinguish between the different requirements of roads in urban and rural areas. In some cases different standards are recommended for rural and urban roads. It may also be necessary to use different weighting factors and to modify the traffic factors.

f. *Requirement*

The system should enable assessments in the field to be made rapidly and uniformly by technicians and should be capable of being processed in a computer and of being readily brought up-to-date.

Comment

Ease of operation and uniformity of results can be obtained by careful design of the system itself and by adequate training of the inspection staff to ensure that they work to a common standard.

g. *Requirement*

It should be designed for eventual integration with an improvement rating system.

Comment

The use of improvement rating systems has hardly been developed yet in this country, but we believe that the value of maintenance ratings would be further increased if improvement ratings were also introduced because the two could then be run in parallel. This would enable authorities to cross check and to identify sections of road where complementary maintenance and improvement is required, for example sections where it would be more economical to delay maintenance to coincide with an improvement or to combine low-cost improvement schemes with maintenance.

Maintenance Functions which would be Covered by a Rating System

8. For maintenance functions which are cyclic—grass cutting, sweeping, gully emptying, sign cleaning etc—a single annual inspection would be of little value. The assessment would need to be on a broad basis taking into account observa-

tions over a year or a season during the course of normal travel. Such assessments would be more a means of judging the adequacy or otherwise of the frequencies of the relevant operations than of establishing priorities. Such an arrangement would not lend itself to the assessment of short lengths of road, as is suggested later for the assessment of the road structure (para 16). Assessments for cyclic operations could *not* therefore be readily integrated into the rating system suggested in this Appendix.

9. Rating systems are more suitable for the assessment of intermittent maintenance needs which are revealed by inspection. These include all the main structural needs and some others, as listed below:—

a. resurfacing and reconstruction of the carriageway and hardshoulders, including corrections to surface irregularity, shape, camber, strengthening of edges, etc;
b. surface dressing for the preservation of the structure;
c. patching;
d. restoration of skidding resistance;
e. maintenance of joints (concrete roads only);
f. maintenance of drainage systems;
g. renewal of road markings;
h. maintenance of kerbs and the provision of kerbs for strengthening carriageway edges;
j. maintenance of footways.

The rating of the various maintenance needs of each defined length of road in an authority should be re-assessed annually by inspections carried out in accordance with the recommendations in Appendix 1, Paras 1.4 and 2.4.

Implementing a Rating System

10. It is important that a maintenance rating system should be developed on a national basis including weighting and traffic factors. It will then be possible to compare maintenance needs between highway authorities and also to obtain consistency in the assessment of needs on trunk roads. This assumes the adoption by all authorities of common standards of maintenance. Ultimately, the maintenance rating system would be based upon objectively determined standards, the determination of which would provide data for the selection of weighting factors.

11. Measurements on a very much larger scale than are at present made for the assessment of maintenance needs are implicit in our recommended standards. The field assessment for the rating system is no more than recording in numerical terms the results of inspections recommended in Appendix 1. A greater staff effort will be required and extra costs incurred but these will be amply justified by the determination of logically based priorities for maintenance and hence the better use of available funds. Where specialist equipment such as SCRIM is not at present available, subjective assessments can be made. This does not

invalidate the system which does not depend upon a total of points and thus any item can be omitted without prejudice to the others.

12. With the present state of knowledge, it is not possible to produce objectively determined weighting factors for inter-item priorities. Indeed in all existing sufficiency rating systems the weighting between the different items considered is largely empirical. Subjective weighting factors have been given in Form II. Traffic factors are even more difficult to determine and none has been given. (In Form II the traffic factor used to illustrate the method is not related to any particular traffic flow). At this stage therefore highway authorities should devise their own traffic factors pending the development of national figures. This will be a considerable advance upon present practice and would greatly simplify the recording and assessment of inspection results.

Suggested Maintenance Rating System

13. The system falls into two parts, the field assessment and the processing in the office. For the field assessment, a simple recording sheet, such as that set out in Form I of this Appendix, is necessary. The processing in the office brings together the field assessments, the weighting factors, and the traffic factors in order to arrive at the final rating for each item of each length of road. Form II illustrates a suitable type of manual data processing sheet but we envisage that the processing would normally be handled on a computer. (The Road Research Laboratory has already prepared a suitable program.) The system is discussed below only in outline and mainly for bituminous roads. It may need further development in places for concrete roads.

The Field Assessment—The System

14. Each item on the field assessment sheet with the exception of item 14 *existing patching* (see para 17.xiii) would be assessed out of 100 points, to the nearest 10 points. The maximum points would generally indicate a completely satisfactory condition and zero points complete unserviceability.

15. The standards given in Appendix 1 indicate the conditions calling for remedial action. For some defects there are different levels of condition at which action is necessary. These levels are termed *critical levels* and are indicated in the rating system by a points allocation of 70, 50 or 30 as set out below. For conditions better or worse than the critical levels, points should be awarded above or below these levels in relation to the degree of divergence from them. For measured values, some form of scale would be necessary to relate the points allocation to the measured divergence. For conditions assessed subjectively points would have to be allotted on the judgment of the inspector.

16. Ratings are designed to be carried out over the lengths of road indicated in Appendix 1, ie lengths of about 500 m. For roads with varying construction along their length or with well defined lengths in different condition the ends of sections should coincide with their points of change. If the maintenance rating

system is to be linked to an improvement rating system, the sections for the two systems should be related. Though on some roads such as motorways, time and effort could be saved by the use of much longer sections up to, say, 5 km, it would be difficult to estimate the proportionate extent of defects over such long lengths.

The Field Assessment—The Method

17. The field assessment should be based on measurement where measurable criteria for standards are defined in Appendix 1 and by judgment where no such criteria are yet available. We give below brief notes on the method of assessment to be applied to each of the items listed in Form I. (All paragraph references in this section relate to Appendix 1 of this report).

(i) *Item 1—Deterioration of the whole surface*
Item 2—Deterioration in the wheel tracks
The assessment of both these items could indicate the need for surface dressing, resurfacing or reconstruction, depending upon the condition in relation to the standards. The critical levels are:—
for surface dressing—70 points or below (para 1.1.2.)
for resurfacing—50 points or below (for bituminous roads paras 1.3.2(i) and (iii) and for concrete roads para 2.2.2.)
for reconstruction—30 points or below (for bituminous roads para 1.3.3(v) and for concrete roads para 2.2.2.)

(ii) *Item 3—Deterioration at the edges*
The assessment of edge deterioration could indicate the need for patching, kerbing or reconstruction (para 1.2.2(iv)). Critical levels are:—
for patching—70 points or below
for kerbing—50 points or below
for reconstruction—30 points or below.
It would take into account any existing pa tching which might be weakening the edges.

(iii) *Item 4—Deformation*
Deformation could indicate the need for resurfacing or reconstruction. Critical levels are:—
for resurfacing—50 points or below (para 1.3.2(ii))
for reconstruction—30 points or below (para 1.3.3(v)).

(iv) *Item 5—Need for patching—to Item 13 inclusive*
Only one level is defined in the standards, so the critical level is 50 points (para 1.2.2. and para 2.1.2.) and lower points would be given for worse conditions.

(v) *Item 6—Camber*
50 points or below should be allotted if the conditions set out in para 1.3.2(vi) are found.

(vi) *Item 7—Surface Irregularity*
50 points or below should be allotted if the conditions set out in para 1.3.2(iv) are found, taking into account that different critical levels apply depending on the type of road being assessed.

(vii) *Item 8—Skidding Resistance*
50 points or below should be allotted when the conditions set out in para 1.1.2(iii) are found. Again the critical level of 50 points should take into account the category of site being assessed, as defined in para 1.1.2(iii), which will be indicated on the field assessment sheet.

(viii) *Item 9—Joints in Concrete Roads*
Spalling at longitudinal or transverse joints is covered by Item 5 above. However transverse joints should also be inspected for the conditions set out in para 2.2.2(ii); if these are found, a rating of 50 or below should be allotted for this item.

(ix) *Item 10—Drainage*
Depending on the type of road being assessed, the critical level of 50 points or below should be allotted where conditions are as set out in para. 4.2.2.

(x) *Item 11—Road Markings*
The critical level of 50 points or below should be allotted where markings have reached the state described in para 10.2(iv).

(xi) *Item 12—Kerbs*
50 points or below should be allotted, taking into account the nature of the road being assessed, when the conditions in paras 5.3.1. or 5.3.2. are found.

(xii) *Item 13—Footways*
If any of the conditions set out in the Note following para 3.3.1. are found, 50 points or below should be allotted.

(xiii) *Item 14—Existing patching*
This is not an assessment of need for maintenance but of actual condition. Its use is explained in para 19. The existing patching, including trench reinstatement, is assessed as follows:—
less than 5% of road surface patched—0 points
more than 5%—5 points.

Data Processing

18. Following the field assessment, the data obtained should be processed as shown in Form II and discussed below. The processing steps are:—

a. adjustments to the assessments of deterioration and deformation to take account of the presence of patching;
b. adjustment to bring skidding resistance into the priority for resurfacing;
c. the coding of the items to indicate critical condition or not;
d. the application of weighting factors related to the importance of the items;

e. the application of a traffic factor to relate priorities to traffic usage; and
f. (not shown in Form II) the establishment of priorities between sections over the whole highway network.

Adjustment for existing patching and trench reinstatements

19. The presence of substantial areas of patching suggests inherent weakness in a road structure while reinstatements provide a built-in source of weakness. These weaknesses should be taken into account in addition to the general structural condition. This is done by subtracting the assessment of existing patching (Item 14 of Form I) from the field assessment for deterioration of the whole road and in the wheel tracks, and for deformation (Items 1, 2 and 4 in Form II). The effect is to increase the priority for such items. The adjustment is not however made to Item 3, deterioration of the edges, the assessment for which would itself take into account any existing patching which might be weakening the edges.

20. Additionally, deflection beam tests might be made on sections where the field assessment shows the existence of patching and the results included in the assessment. The rating could then be related to the expected future life of the pavement without further treatment and taking into account cumulative future heavy vehicle traffic.

Adjustment for Skidding Resistance

21. Loss of skidding resistance is an important factor in determining the need for surface treatment. We were however unable to recommend an absolute standard for skidding resistance in Appendix 1 (para 1.1.2) but only that action should be taken when skidding resistance falls 'significantly below' the figures quoted. Nevertheless if two sections of road are equally in need of treatment for structural reasons, that with the worse skidding resistance (if it is at all below standard) should receive priority. This can be done, as shown in Form II, by deducting from the field assessments for deterioration and deformation the points by which the field assessment for skidding resistance is below the critical level of 50 points.

Coding of Critical Levels

22. Critical levels are indicated in the proposed system by a letter code on the following basis:—

C = Critical
CSD = Critical for surface dressing
CRS = Critical for resurfacing
CRC = Critical for reconstruction
CP = Critical for patching
CK = Critical for kerbing
CR = Critical for reconstruction
} For edges only
S = Satisfactory

Critical levels are shown in Form II, column (g).

Weighting factors

23. The critical levels indicate only that conditions require remedial treatment. They do not necessarily show the relative urgency of critical items. To assign priorities for action within each road section, weighting factors should be applied to the adjusted field assessments (Form II column (h)). The values in Form II column (h) are a tentative attempt to show realistic priorities, giving most weight to structural condition followed by safety and comfort. They require further study. Ultimately, it is hoped that they will be based on objectively determined standards.

Adjustment for traffic

24. The final adjustment (Form II column (j)) would be for traffic so that the final ratings could be compared with similar ratings on different sections of road and so give an overall priority for work irrespective of the type of work and traffic-usage. The standards given in Appendix 1 take traffic into account, but only in very broad terms. The traffic factor could be determined on a finer basis and give better priorities within the broad groups. For very light traffic, a factor of 1 would be used with factors of less than 1 for heavier traffic flows. In the example a traffic factor of 0·8 has been used but no attempt has been made to associate this with any particular traffic flow. The values finally adopted for traffic factors need to be considered very carefully if they are to afford a true reflection of maintenance needs in relation to the demands and effects of traffic.

Final Ratings

25. The final ratings shown in column (j) of Form II serve two purposes. First they identify the most urgent items of work within each road section and also, since they have taken into account differing traffic flows and type of road, the most urgent item of work within the whole highway network.

Within-section assessment

26. Form II shows the type of sheet required for manual processing in which each step is worked out for a hypothetical section of road. In practice, it is envisaged that the processing would be by computer and the print-out limited to columns (g) and (j). Column (g) shows which items are critical and column (j) indicates work priorities within the section, the lowest figure indicating the most urgent item.

27. In the section of road described in Form II all items except edges, drainage and kerbs have reached a critical level. The final ratings show that reconstruction is the first priority; it will not only correct the structural defects due to deterioration and deformation, but also low skidding resistance, high surface irregularity, and adverse camber. The low ratings for the renewal of road markings and for patching indicate a high priority for these items too. Both would be taken care of in due course by the reconstruction but, with a probable delay between assessment and treatment of at least 6 months, the ratings suggest that a check

should be made to ensure (i) that the markings are not so defective as to constitute a hazard to road users and (ii) that patching is being undertaken as necessary to arrest undue further deterioration.

Between-section assessment

28. To obtain absolute priorities for work over a highway network the use of an overall rating for each section, obtained by summing the final ratings was considered. This proved impracticable because a section with a single very critical item but which was otherwise satisfactory would have a high overall rating and would then be indicated as having low priority. It is therefore proposed to base absolute priorities on the lowest individual ratings within sections. The computer would be programmed first to locate that section with the lowest rated critical item and to print out the data relating to that item under a 'priority' heading. Alongside, under a 'section data' heading, it would print out all the data relating to the whole section. This section would then be eliminated from further processing and the process repeated for the remaining sections. Sections with no critical items would not appear in the print-out.

Further Developments

29. Work on footways, kerbs, markings and drainage is often independent of major maintenance work on carriageways and it might be unnecessary to include these items in the overall priority print-out. Complementary print-outs could be made to group sections in order of priority for similar treatment, eg all sections critical for surface dressing. These print-outs would include independent priorities for footways, kerbs etc, and would assist in the preparation of the annual programme for the relevant maintenance function. Print-outs could also be made to group sections in consecutive order for specific lengths of road to provide a picture of conditions over these lengths.

30. Information showing that sections were earmarked for improvement could be fed in with the field assessment data to indicate where maintenance might be better postponed or be combined with the improvement work. If an improvement rating system were being operated, the two systems could be linked to provide this information on the print-out. Other known factors, bad accident records for example, likely to influence priorities could also be fed in with the field assessment data.

Form I—Field Assessment Sheet

Road:

Classification:

Section:

Grid Reference:

Skidding Category /_____/ site.

Traffic flow:

Scheduled for Improvement	Yes	No	Office Use Only
Bad Accident Record	Yes	No	

Item No.	Item	Critical Level*	Field Assessment
1	Deterioration:		
	Whole surface	SD70; RS50; RC30	60
2	Wheel tracks	SD70; RS50; RC30	40
3	Edges	P70; K50; RC30	90
4	Deformation	RS50; RC30	50
5	Need for patching	P50	40
6	Camber	50	40
7	Surface irregularity	50	40
8	Skidding resistance	50	40
9	Joints (concrete roads)	50	—
10	Drainage	50	60
11	Road markings	50	20
12	Kerbs	50	40
13	Footways	50	60
14†	Existing patching	0 or 5	5

*Abbreviations under this heading:
RC—reconstruction
RS—resurfacing
SD—surface dressing
P —patching
K —kerbing

†Less than 5%, 0 points
5% or more, 5 points

Form II—Manual Data Processing Sheet

Road:
Section:
Grid Reference:
Traffic Group:
Traffic Factor: 0·8
Existing Patching: 5 (from field assessment)

Item No. (a)	Item (b)	Field assessment (c)	Adjust for patching (d)	Adjust for skidding resistance (e)	Unweighted assessment (f)	Critical and Satisfactory (g)	Weighting Factor (h)	FINAL RATING including traffic factor (j)
	Deterioration of:							
1	Whole surface	60	55	45	45	CRS	0·2	7·2
2	Wheel tracks	40	35	25	25	CRC	0·2	4·0
3	Edges	90	—	—	90	S	0·2	—
4	Deformation	50	45	35	35	CRS	0·2	5·6
5	Need for patching	40	—	—	40	CP	0·2	6·4
6	Camber	40	—	—	40	C	0·5	16·0
7	Surface irregularity	40	—	—	40	C	0·4	12·8
8	Skidding resistance	40	—	—	40	C	0·3	9·6
9	Joint (concrete roads)	—	—	—	—	—	0·4	—
10	Drainage	60	—	—	60	S	0·3	—
11	Road markings	20	—	—	20	C	0·3	4·8
12	Kerbs	60	—	—	60	S	0·4	—
13	Footways	40	—	—	40	C	0·3	12·8

Appendix 3: Expenditure Decisions

Value of Economic Assessment

1. The systematic use of economic justifications of expenditure was rarely seen in the highway authorities visited in the course of our studies. Such justifications should however be used in highway maintenance, for they show which items of expenditure are most worthwhile and emphasise the extra future cost which may be involved in decisions to restrict present year expenditure to the minimum cost options. An essential part of sound management is the evaluation of alternatives to show the economics of making a decision, even if the final decision will not be made entirely on economic grounds. Decisions such as these might involve choices about:—

a. the type of maintenance to be undertaken
b. owning as against—long-term hiring
—short-term hiring
c. using direct labour or contract
d. making or buying.

The techniques which should be used to evaluate these decisions are similar because they all involve comparing alternatives over a given length of time.

Short-Term Decisions

2. These are the day to day decisions a highway authority has to make such as whether:—

a. a specific job should be done by a contractor or by direct labour.
b. plant should be hired specifically for a job or the work undertaken without that plant.

Forecasts of the expenditure for the alternatives should be followed by an assessment of the most economic method. In making this assessment it is important that only those extra costs which are incurred as a direct result of choosing an alternative are included, ie costs which would be incurred whether or not that choice was made must be ignored (see Example 1).

Long-Term Decisions

3. These decisions involve commitment over a number of years and include questions such as:—

a. should a certain road be resurfaced this year or later?
b. should certain functions of maintenance be undertaken by contractors?

c. when should items of plant most economically be replaced?
d. is it more economic to own or hire an item of plant?

4. The steps involved in assessing projects are:—
a. considering all feasible alternatives;
b. forecasting annual expenditure on each of these;
c. discounting these expenditures to an Equivalent Present Cost.

5. In step 4(b), forecasting annual expenditure, consideration must be given to the length of time to be covered. Ideally the economic assessment should include all the years during which the level or time pattern of expenditure is affected by the particular decision. For example, in buy versus hire decisions this period will be the economic life of the equipment, or the period for which it is intended to use the equipment if this is less than the economic life. In other situations the appropriate period is up to the point where an identical expenditure decision appears in the same year in the cost streams of the alternative courses of action. (See Example 2 where the residual value of the road surface is zero at the end of year 9 in both alternatives). In practice, this period could however be very long and we suggest that a maximum period of ten years should be considered, providing proper account is taken of the residual values at the end of this period. The examples include residual values. For plant this is the resale value but for roads it is a notional value calculated by dividing the cost of the treatment by the expected years of life of that treatment on the assumption that the value decreases by that amount each year.

6. Step 4(c), discounting, is needed because the financial evaluation of these projects must take into account the fact that a sum of money not spent this year can be invested at, say, 10% and thus increase its value over the years: £91 not spent this year will be worth £100 next year. On the other hand inflation must be ignored; the evaluation should be carried out in constant prices. All the examples we provide use a discount rate of 10% because this is the rate used by central government. We believe that there would be long-term advantages of consistency and comparability if local authorities were to adopt the central government rate in their evaluation of projects. The 10% discount factors used are the following:—

Year	Discount Factor
1	1·000
2	·909
3	·826
4	·751
5	·683
6	·621
7	·564
8	·513
9	·467
10	·424

The alternative with the lowest Equivalent Present Cost is the most economic course of action for each project. Calculation of the Equivalent Present Cost

also enables authorities to rank the projects in order of priority if funds do not permit them to adopt the preferred alternative in every case (see para 18).

7. This Appendix includes a number of examples of the type of calculations authorities may need to make. These calculations have however been set out as simply as possible in order to emphasise the advantages of discounting. For example they demonstrate only two alternatives where in fact it may be necessary to consider several before being able to identify the most economic. We accept such limitations in the belief that the approach we are recommending represents a major step forward from present methods of project selection.

a. *Type of Maintenance to be Undertaken*

8. We believe that the discounting technique will be appropriate in most cases for structural maintenance projects, in other words for the projects to be carried out with the funds which remain after an authority has allocated sums to other, cyclic functions. This does not however preclude the use of the technique to assist in allocating funds to other maintenance works.

9. It is assumed that the level of funds available for maintenance purposes for the year in question is sufficient to ensure that at least some maintenance is possible on all sites where this is needed; and that this minimum level of maintenance is such that there is no substantial difference in the benefits to road users between the maintenance alternatives for a given stretch of road. It is also assumed that the process of allocating restricted funds between projects will be conducted annually. However, financial evaluations should be reviewed sooner if the costs of any projects change significantly in the course of a year.

10. Most structural maintenance projects present the choice of carrying out expensive work now or of carrying out only holding operations in order to spread the available funds more widely. Since the proposal is that maintenance needs should be reviewed each year, we suggest that the economic assessment of each project should be based on a comparison between the alternative involving major expenditure this year and that involving the minimum cost this year and the major expenditure next year. As in Example 3, costs may be substantially increased (in real terms) as the result of this deferment though, as Example 2 demonstrates, this is not necessarily so.

11. This method is in no way biased towards the shorter term solution. Indeed as many examples, (3–8), to this Appendix show, the best economic solution would often be that involving heavy expenditure in the current year.

b. *Contract or Direct Labour*

12. A long-term assessment of the economics of employing a contractor for a particular maintenance function is set out in Example 4. The costs of employing a contractor are not restricted, as in the example, to the contractor's quoted price. Authorities should add to this price a sum to cover their own additional costs, ie over and above normal establishment costs, in supervising the contract.

c. *Optimum point of replacement for vehicles and plant*

13. A method of determining the economic life of plant and of deciding whether the plant should be retained for a further period is described in Example 5. First, by applying the method to the data for a typical item of plant and comparing the present costs of replacement for each pair of consecutive years, it is possible to determine the probable economic life of plant of that type. This calculation need be made only for one item of each group of like vehicles or plant. However the base calculation itself will need checking periodically if, say, the purchase price or any design feature alters substantially.

14. Authorities should keep records for each vehicle/item of plant, covering such variable factors as repair costs and replacement price. Where an item of plant follows the pattern for its type, the method described above can be applied as the replacement date approaches to determine, whether, given the level of funds available, it is economically preferable to replace it immediately or to retain it for a further year.

15. If for any reason the individual item shows a clear deviation from its type at any time, the same calculation will show whether immediate replacement is preferable to retention for a further year or for the originally expected economic life.

d. *Buying or hiring plant*

16. The choice between buying and hiring will turn largely on the number of hours of work which are expected to be available over a period for a particular item of plant. If it can be kept occupied for a high proportion of its time it is likely to be cheaper overall to buy; if only for a low proportion of its time it is likely to be cheaper overall to hire. The financial choice must be made on a comparison of hourly hiring charges on the one hand and the corresponding storage, maintenance and depreciation charges (taking into account varying disposal value) divided by the expected number of hours used on the other. Other considerations such as the ready availability of an item of plant may enter into the decision. The circumstances would vary so much that it would not be possible to set down here all the factors which should be considered. Our concern is to emphasise that the decision should be a deliberate one made after appropriate financial comparison. Even an authority which owns a substantial fleet should not automatically assume that additional items should be bought.

17. The simplified Examples Nos. 6–8 assume that authorities might contemplate long-term contract hire of vehicles or plant. We realise that this may be unusual unless the authority were short of capital funds but we believe that it is important to assess the position economically. As Example 8 shows, long-term contract hire may, given a particular hire charge, be the more economic course of action.

Selecting Priorities

18. Economic assessment may identify so many projects on which major expenditure would be justified in the current year that the year's budget cannot

accommodate them all. In that case the projects can be ranked in order of desirability by means of an Expenditure Priority Index (EPI). This is calculated as follows:—

$$EPI = \frac{\text{Difference in Total Equivalent Present Costs}}{\text{Difference in Present Year Expenditure}}$$

If for any given project there should be more than one alternative with identical minimum present year costs, calculation of the EPI should be based on the one with the lowest equivalent present cost. The method of calculation is set out in Example 9 and EPIs are calculated where appropriate in each of the other examples. The higher the EPI, the more desirable the project and an authority which allocated its entire funds for marginal projects on this basis would be making the most economic choices (see Example 10).

Cost of Deferment

19. Generally the available level of funds will oblige authorities to defer major expenditure on some projects for which, taken individually, it would be justified. Each such deferment due to scarcity of funds implies a cost, known as the *shadow cost*. This is the difference between the equivalent present costs of the alternatives. The total shadow cost is simply the sum of these differences for all the projects on which economically desirable major maintenance expenditure is deferred (see Example 10). This shadow cost should be calculated to assess the economic cost imposed in the maintenance operation by current shortage of funds.

20. The decision on the standards (frequency and cost) to be achieved in cyclic and amenity functions will generally continue to be a matter of judgment, decided by the appropriate Committee. We suggest that when making these choices they should have before them both the cost of the measures they are considering and the shadow cost this involves in deferment of expenditure on other maintenance.

Size of Projects to be Evaluated

21. It will not be economic to use the proposed evaluation technique for expenditures of very small sums. However it is worth noting that if the improvement in decision-making saved only 3% of expenditure and the cost of making a decision in this way was estimated to be £3, (a technician for a half day), it would be economic to assess all projects involving over £100 expenditure. Both these assumptions are conservative.

Example 1: Short Term Assessment

Contract or direct labour

Minor drainage scheme

Alternative 1.	DIRECT LABOUR AND PLANT	
	Labour cost	£360
	Excavator required for 3 days	
	Cost rate	£3 per hour running £2 per hour standing
	Transportation cost	£10
Alternative 2.	CONTRACTOR'S QUOTE	£470

Assume:

a. Excavator estimated to work 18 hours, to stand 6 hours if work done by direct labour.

b. That excavator would be standing idle if this job done by contractors.

Own Cost Calculation	Total cost of Alternative 1.	Direct Cost of Alternative 1.
	£	£
Direct Labour	360	360
Excavator 18 hours at £3	54	18*
6 hours at £2	12	
Transportation	10	10
Materials	45	45
	481	433

*18=18 hours at marginal running cost, ie £3–£2. Only £1 per hour needs to be charged to this job as the standing charges are incurred whether or not the excavator is used. The difference in cost of £48 between the total and direct cost is 24 hours @ £2 per hour.

Conclusion

Since the contractor's price was £470, the job should be done by direct labour, at a saving in direct cost of £37 or nearly 9%.

Example 2: Example in Structural Maintenance

Problem A rural road in poor condition, 24 foot wide carriageway and 1 mile long.

Alternatives
1. Resurface this year and surface dress in year 7.
2. Patch and surface dress now, resurface in year 4.

Costs Resurfacing with carpet coat to give life of 6 years (ie zero residual value at end of 6 years)=£6,700.
Patching 25% of surface area to give a 3 year life=£1,056.
Surface dressing to give 3 year life=£900.

Year	Discount Factor	Method 1		Method 2	
		Actual Cost (£)	Equivalent Present Cost (£)	Actual Cost (£)	Equivalent Present Cost (£)
1	1·000	6,700	6,700	1,956	1,956
2	·909				
3	·826				
4	·751			6,700	5,032
5	·683				
6	·621				
7	·564	900	508		
8	·513				
9	·467				
Total equivalent present cost			7,208		6,988

In this case the method with the lowest equivalent present cost is Method 2 which also has the lowest first year costs. The extra expenditure involved in resurfacing this year is therefore not justified. In this example the cost streams have been compared over 9 years because both methods have residual values of zero at the end of 9 years.

Example 3: Example in Surface Maintenance

Problem A rural road in sound condition with a worn surface, 24 foot carriageway, 1 mile long.

Alternatives
1. Patch 10% of surface area and surface dress, now and repeat in year 6.
2. Patch 25% and surface dress in year 2 and patch 10% and surface dress again in year 7.

Costs
Patching 10% of surface area =£423
Patching 25% surface area =£1,056
Surface dressing to give 5 year life=£900

Year	Discount Factor	Method 1		Method 2	
		Actual Cost (£)	Present Cost (£)	Actual Cost (£)	Equivalent Cost (£)
1	1·000	1,323	1,323		
2	·909			1,956	1,778
3	·826				
4	·751				
5	·683				
6	·621	1,323	822		
7	·564			1,323	746
8	·513				
9	·467				
10	·424	(nil)	(nil)	(265)*	(112)
Total equivalent present costs			2,145		2,412

*Residual value $\left(\frac{1323}{5}\right)$

The net benefit from patching and surface dressing this year as opposed to leaving it for 1 year is £267 as against an extra present year cost of £1,323.

The EPI is therefore $\frac{£267}{£1,323} = ·202$ (see Example 9).

Example 4: Long Term Assessment

Direct Labour or Contract

Decision Should a local authority empty its own gullies or hire a contractor to do so?

Assumptions

a. 17,400 gullies to be emptied in year.

b. Contractor's price—3/8d per gully.

c. Council costs— New vehicle £2,500—which has zero residual value at end of 7 years. Running costs and standing charges—see table below. Driver's and mate's wages, say, £1,800 a year.

d. Council uses 10% discount rate.

Calculation

1. COST OF CONTRACTOR

Contractor's price*
17,400 gullies at 3/8d=£3,190

Equivalent Present Cost of contractor for 7 years
£3,190 pa × 5·354† = £17,079

2. COUNCIL'S OWN COSTS

Year	Capital Cost	Running Costs	Wages	Total Cost	Discount Factor	Equivalent Present Cost
	£	£	£	£	£	£
1	2,500	300	1,800	4,600	1·000	4,600
2		300	1,800	2,100	·909	1,909
3		350	1,800	2,150	·826	1,776
4		450	1,800	2,250	·751	1,690
5		550	1,800	2,350	·683	1,605
6		700	1,800	2,500	·621	1,552
7		900	1,800	2,700	·564	1,523
						14,655

EPI (see Example 9)

The difference between the two equivalent present costs is therefore £17,079 less £14,655=£2,424.

The difference between the two first-year costs is £4,600 less £3,190=£1,410.

*This does not include any additional costs to the Council in supervision etc.

†This is a composite 7 year discount factor, representing the sum of the 10% discount factors for years 1–7 inclusive.

The EPI is therefore

$$\frac{£2,424}{£1,410}=1\cdot719$$

Note: The value of the EPI in this example is based on the assumption that, if the local authority does not empty its own gullies this year, it will adopt the alternative policy of employing a contractor for seven years. If however the most probable alternative action is merely to put off the major expenditure for one year and then to undertake its own gully emptying, then the EPI will be different and must be calculated with the appropriate costs.

Example 5: The Optimum Replacement Policy and the Replacement Decision

I *Calculation of Expected Economic Life or Optimum Replacement Policy*

1. A local authority proposes to purchase a lorry costing £3,000, with the following maintenance and operating costs and residual values:

Year	Operating costs (£) (including maintenance)	Residual value (£) (resale value, at end of year)
1	3,000	2,000
2	3,500	1,200
3	4,000	750
4	4,500	250
5	5,000	100

Assumption:

2. For simplicity, and consistency with the other examples, it is assumed that old lorries are scrapped at the end of a year and the replacement lorry is purchased at the beginning of the following year. The optimum replacement policy is therefore calculated as follows:—

		Replacement every 3 years				Replacement every 4 years			
Year	Discount Factor	Capital Cost	Operating Cost	Total Cost	Equivalent Present Cost	Capital Cost	Operating Cost	Total Cost	Equivalent Present Cost
		£	£	£	£	£	£	£	£
1	1·000	3,000	3,000	6,000	6,000	3,000	3,000	6,000	6,000
2	·909		3,500	3,500	3,182		3.500	3,500	3,182
3	·826	(750)	4,000	3,250	2,685		4,000	4,000	3,304
4	·751	3,000	3,000	6,000	4,506	(250)	4,500	4,250	3,192
5	·683		3,500	3,500	2,390	3,000	3,000	6,000	4,098
6	·621	(750)	4,000	3,250	2,018		3,500	3,500	2,173
7	·564	3,000	3,000	6,000	3,384		4,000	4,000	2,256
8	·513		3,500	3,500	1,795	(250)	4,500	4,250	2,180
9	·467	(750)	4,000	3,250	1,518	3,000	3,000	6,000	2,802
10	·424	1,000*	3,000	4,000	1,696	(1,200)	3,500	2,300	975
Total Equivalent Present Costs					29,174				30,162

*Capital cost less residual value of £2,000.

3. The Equivalent Present Cost of a three year replacement policy is less than that of a four year replacement policy. A similar comparison between two year and three year replacement policies shows that a three year cycle has a lower equivalent present cost than a two year cycle. Thus a three year cycle is the optimum replacement policy, ie the lorry has an economic life of three years.

II *Replacement Decision*

4. When a vehicle comes to the end of its economic life, it may not be possible to replace it if funds are restricted. In this event the Expenditure Priority Index (see Example 9) of replacement immediately, as opposed to postponing replacement for one year, can be calculated. In doing this it should be assumed that

even though shortage of funds may on this occasion prevent replacement after three years, the optimum replacement policy will nevertheless be followed in the future.

5. Continuing the example above, assume that the lorry is three years old and has reached the end of its economic life:—

		Replacement Now				Replacement in One Year			
Year	Discount Factor	Capital Cost	Operating Cost	Total Cost	Equivalent Present Cost	Capital Cost	Operating Cost	Total Cost	Equivalent Cost
		£	£	£	£	£	£	£	£
1	1·000	3,000	3,000	6,000	6,000		4,500	4,500	4,500
2	·909		3,500	3,500	3,182	3,000	3,000	6,000	5,454
3	·826	(750)	4,000	3,250	2,685		3,500	3,500	2,891
4	·751	3,000	3,000	6,000	4,506	(750)	4,000	3,250	2,441
5	·683		3,500	3,500	2,391	3,000	3,000	6,000	4,098
6	·621	(750)	4,000	3,250	2,018		3,500	3,500	2,174
7	·564	3,000	3,000	6,000	3,384	(750)	4,000	3,250	1,833
8	·513		3,500	3,500	1,795	3,000	3,000	6,000	3,078
9	·467	(750)	4,000	3,250	1,518		3,500	3,500	1'635
10	·424	1,000*	3,000	4,000	1,696	(750)	4,000	3,250	1,378
	Total Equivalent Present Costs				29,175				29,482

*Capital cost less residual value of £2,000.

The net benefit from replacing now is £307 as against an extra present year cost of £1,500.

The EPI is therefore $\frac{£307}{£1,500} = 0{\cdot}205.$

Example 6: The Hire Versus Buy Decision

Decision Should a local authority buy a rubber tyred roller for use only in surface dressing, or should it hire one?

Assumptions

a. A 40 hour week over 20 weeks.

b. The roller costs £4,250, has a residual value of £300 after 10 years and costs £1,400 per annum to operate (35/– per hour).

c. The cost of hiring a similar roller is £1,660 per annum (41/9 per hour).

Owning Cost

Year	Discount factor	Capital Cost	Operating Cost	Total Cost	Equivalent Present Cost
		£	£	£	£
1	1·000	4,250	1,400	5,650	5,650
2	·909		1,400	1,400	1,272
3	·826		1,400	1,400	1,156
4	·751		1,400	1,400	1,051
5	·683		1,400	1,400	956
6	·621		1,400	1,400	869
7	·564		1,400	1,400	790
8	·513		1,400	1,400	718
9	·467		1,400	1,400	654
10	·424	(300)	1,400	1,100	466
Total equivalent present cost					13,582

Hiring Cost

Actual hiring cost=£1,660

Equivalent present cost=1,660×sum of the discount factors over 10 years

=£1,660×6·758

=£11,218

In this case the equivalent present cost of hiring is lower than that of buying. Thus in this example the extra expenditure in the present year to buy rather than hire is not justified.

Example 7: The Hire Versus Buy Decision

Decision Should a local authority buy a 3-way tipper or should it hire one?

Assumptions

a. The lorry is to be used for a 48 hour week over 48 weeks.

b. The lorry costs £2,458, has a residual value of £215 at the end of 6 years and costs £2,530 per annum to operate (22/– per hour).

c. The cost of hiring a similar lorry is £3,450 per annum (30/– per hour).

Owning Costs

Year	Discount factor	Capital Cost	Operating Cost	Total Cost	Equivalent Present Cost
		£	£	£	£
1	1·000	2,458	2,530	4,988	4,988
2	·909		2,530	2,530	2,300
3	·826		2,530	2,530	2,090
4	·751		2,530	2,530	1,900
5	·683		2,530	2,530	1,728
6	·621	(215)	2,530	2,315	1,438
Total equivalent present cost					14,444

Hiring Costs

Actual hiring cost = £3,450 per annum over 6 years

Equivalent present cost = £3,450 × sum of discount factors over 6 years

= £3,450 × 4·790

= £16,525

The net benefit from buying rather than hiring is £2,081 as against an extra present year cost of £1,538.

The EPI is therefore $\frac{£2,081}{£1,538} = 1{\cdot}353$ (See Example 9)

Note: See Note at end of Example 4.

Example 8: Long Term Assessment

Decision Should an authority buy or hire a lorry, depending on the hiring rate and given a 5 year life for the lorry if it buys it?

Assumptions

a. Discussion concerns an all-purpose lorry costing £4,200 with an optimum economic life of 5 years.

b. Residual value of lorry is £1,700 after 5 years.

c. Maintenance costs assumed to rise from £200 in year 1 to £410 in year 5.

Calculation

Buy and Retain for 5 years

Year	Discount Factor	Owning Cost		Discounted Hire Charge		
		Actual Cost	Equivalent Present Cost	£1,100 pa	£1,000 pa	£900 pa
		£	£	£	£	£
1	1·000	4,400*	4,400	1,100	1,000	900
2	0·909	230	209	1,000	909	818
3	0·826	260	215	909	826	743
4	0·751	320	240	826	751	676
5	0·683	(1,290)†	(881)	751	683	615
Total			4,183	4,586	4,169	3,752

*—Including £200 for maintenance.

†—Residual Value less maintenance cost.

In this example the local authority should purchase a vehicle only if the hire charge were £1,100 pa. The EPI (Example 9) for purchase in that case is $\frac{£403}{£3,300}=0·122$.

Example 9: Calculation of the Expenditure Priority Index Value

The following calculation, using the figures given in Example 3, shows how the Expenditure Priority Index value for a particular scheme is derived.

Total Equivalent Present Cost—Method 2	£2,412
Total Equivalent Present Cost—Method 1	£2,145
Difference in Total Equivalent Present Costs (savings)	£ 267
Expenditure in Present Year—Method 1	£1,323
Expenditure in Present Year—Method 2	Nil
Difference in Present Year Expenditure (increase)	£1,323

$$EPI = \frac{\text{Difference in Total Equivalent Present Costs}}{\text{Difference in Present Year Expenditure}} = \frac{£\ 267}{£1{,}323}$$

Hence EPI=0·202 for this project.

Values for the Expenditure Priority Index for other projects are obtained in the same way, taking the ratio of the

$$\frac{\text{Difference in Total Equivalent Present Cost between Alternatives}}{\text{Difference in Present Year Expenditure between Alternatives}}$$

in each case.

Example 10: Allocating Funds by Economic Priority

1. Assume the following situation:—

Total funds available	£160,500
Deduct required expenditure on service items (sweeping, grass cutting, gully cleansing, lighting)	£101,500
Deduct structural surface maintenance items which cannot be deferred for engineering reasons	£46,500
Balance available	£12,500

The remaining projects were included in draft estimates:—

Project	Description of Alternatives	Desirable Course	Minimum Cost Option	Additional Cost of Desirable Course	Difference in Total Equivalent Present Costs	EPI
A	High Street Roundabout (4,000 yds.²) Resurface Surface dress and patch	£ 2,000	£ 500	£ 1,500	£ 840	·56
B	High Street (1,000 yds long × 36 ft wide) Resurface Patch and surface dress	6,000	900	5,100	1,785	·35
C	Southern By-Pass (5,000 yds dual 24 ft) Light patch and surface dress Patch extensively	5,000	2,400	2,600	650	·25
D	Main Street (800 yds 36 ft wide) Resurface with carpet Patch and surface dress	5,000	900	4,100	615	·15
E	Mill Lane (1,500 yds 18 ft wide) Light patch and surface dress Patch extensively	800	275	525	52	·10
F	Rectory Close (500 yds 21 ft wide) Prepare and surface dress Patch extensively	280	150	130	6	·05
	TOTALS	19,080	5,125	13,955		

2. As can be seen, these projects would involve a maximum expenditure of £19,080 if all were done in a way which minimised total future costs, and a minimum expenditure of £5,125 if the *minimum present year cost* option was adopted.

Example of Allocation of Funds

3. Of the total £12,500 available for these projects, a minimum expenditure of £5,125 will be required. Thus £7,375 will be available for the additional cost of preferred alternative courses. Using the EPI to select the priority projects and allocating £7,375 among them the following would be done:—

Project	*Extra Cost*	*Cumulative Extra Cost*	*EPI*
A	£1,500	£1,500	0·56
B	£5,100	£6,600	0·35

4. The projects which are recommended for immediate adoption are therefore projects A and B. However the balance of the funds is not completely allocated—£775 remains. The authority then has a choice: it can adopt projects E and F with EPIs of 0·10 and 0·05 respectively but the joint additional cost of which, £685, can be met from the budget; alternatively it could examine the programme for non-structural maintenance functions and consider whether £1,825 could be reasonably released from that to allow it to carry out project C with an EPI of 0·25.

5. This method will generally be found to yield the best set of decisions. If, however, the programme can be dominated by one or a small number of projects, some caution is necessary, since simple choice by EPI ranking may not in such cases yield the highest value.

Shadow Cost

6. Assuming that it were found possible to carry out project C, the *shadow cost* (see para 19 of introduction to this Appendix) of deferring projects D, E and F would be the sum of the differences in their total equivalent present costs:—

D	£615
E	£ 52
F	£ 6
	£673

Given the budget available, this is in fact the minimum possible shadow cost from the various alternative combinations of projects.

Appendix 4: Assessment of Productivity

Part A: Procedure

There are four principal stages in making a productivity assessment and in determining the scope for improvement using the standard times contained in this report:

a. Record the work done and time taken for a representative sample or samples.
b. Evaluate the work done in Standard Minutes or Standard Hours.
c. Calculate the Effective Performance (productivity) for the sample.
d. Assess the scope for improvement.

These four stages are described in detail below.

1. RECORD THE WORK

Few authorities without incentive schemes have work recording systems which are sufficiently detailed or accurate for productivity assessment. A temporary system must, therefore, be installed to provide the required information. The Standard Minute Values (SMVs) on which our proposed system is based are set out in Part B of this Appendix. The SMVs for each activity are averages of values found in a large number of authorities. No single SMV can therefore be taken as universally valid, hence our emphasis on the need for a broad work sample on which to base the productivity assessment. The following points should be noted:—

a. Work must be recorded in the units used in the tables of Standard Minute Values (SMVs) in Part B of this Appendix. For example:—laying of bituminous material should be measured in square yards and not tons.
b. The work sample must contain the full range of activities carried out in the highway authority (probably about 30 different operations) and in proportions similar to the whole authority.
c. The sample must be large enough to achieve a satisfactory level of accuracy. We suggest at least 600 Standard Hours.
d. Only productive work should be recorded; details of travelling, loading and unloading lorries etc, are not required.
e. The total time clocked by all the men, including the ganger, involved in the work sample, including the time spent waiting or on non-productive work should be recorded. Time lost due to wet weather is the only time deducted from the total clocked time.
f. The clock time of lorry drivers is not included in the total. Owing to different systems of working, it has been found to be impossible to share their time

satisfactorily to each job. The selected productivity targets were calculated after any work done by lorry drivers and their clock time had been excluded.

g. Gangers will become quite good at recording and measuring work with experience; however they will require considerable assistance during the early stages. The commonest mistake is for parts of the work to be forgotten.

2. EVALUATE THE WORK

The tables of SMVs which follow have been found adequate to evaluate all the operations in the samples assessed in the consultants' visits. The operations contained in the tables are of two types:—

a. Package operations in which the SMV for a complete job is quoted: for example:—lift and relay kerbs on hand-mixed concrete.

b. Individual operations in which the SMV for a single function is quoted: for example:—excavate by hand.

2.1. EVALUATION PROCEDURE

The procedure for evaluating the work content of the sample is as follows:—

(i) List the jobs carried out, ensuring that they are broken down into operations whose descriptions correspond with those in the table of SMVs.

(ii) List the quantities of each operation completed, converting the units if necessary into those corresponding to the SMV for the operation.

(iii) Extract the SMV from the tables and write it adjacent to the quantity.

(iv) Multiply the quantity by the SMV to give the work content of each operation in Standard Minutes.

(v) Add the work content of all the operations in the sample to give the total work content of the sample in Standard Minutes.

(vi) Divide the total by 60 to present the work content in Standard Hours.

During the evaluation of the work sample, the following points should be noted:—

a. Every piece of productive work in the sample must be evaluated and included in the total.

b. Where a suitable package operation SMV is not quoted, the work must be broken down into its individual operations, and each operation evaluated separately.

c. The large number of minor variations in method and conditions which exist nationally prevent the presentation of SMVs to cover every possible alternative. The principle of this presentation is that the nearest equivalent operation should be selected.

3. CALCULATE THE PRODUCTIVITY

The measure of productivity used in this report is the Effective Performance or ratio between productive work done and actual time taken. The procedure for

calculating the Effective Performance is:—

a. Total all the hours clocked by every man working on the work sample including gangers but excluding lorry drivers.
b. Subtract any time lost by the men due to wet weather.
c. Divide the net time taken on the work (calculated in 3(b)) into the total Productive Standard Hours of work done (calculated in 2.1.(vi)) and multiply by 100. This figure is the Effective Performance of the sample.

4. ASSESS THE SCOPE FOR IMPROVEMENT

The productivity targets stated in Chapter 6 (para 3) have been selected as representative of results that are being achieved in authorities with the aid of incentives, improved methods and management techniques. The percentage improvement achieved by reaching the target levels is calculated as follows:—

a. Select the appropriate target.
b. Subtract the Effective Performance (calculated in 3(c)) from the target, divide the result by the Effective Performance and multiply by 100.

The result is the potential improvement in productivity expressed as a percentage. An example of the calculations set out in sections 2.1, 3 and 4 is shown on the following page.

5. CONCLUSION

The procedures outlined above enable the scope for the improvement in productivity that could be obtained by the installation of incentives and improved management techniques to be assessed.

Our experience has shown that the answer may be distorted by certain factors.

Any unusual interest by management will tend to make the men work harder. Therefore the installation of a temporary work recording system will automatically raise the level of productivity and create a false picture. This problem can only be overcome by allowing the system to run until the men relapse into their old ways.

Junior supervision—gangers and foremen—will feel that a poor result will reflect unfavourably upon them. They will therefore make exceptional efforts to ensure that materials are available and that work is properly organised. Again, a false picture will be created.

Supervision will try to include only their better workers in the work sample and gangers may join in productive work where normally they only supervise.

The effect of all these factors is to improve the current level of productivity and reduce the apparent scope for improvement. But their effect will not be maintained and the assessment must be considered in the light of the possible distortion.

6. EXAMPLE OF PRODUCTIVITY ASSESSMENT

Note: For simplicity this example includes only 2 operations. This would be insufficient in a real case for any confidence to be placed in the answer.

.....**U.D.C.**

Operation	Quantity	S.M.V. per 100 sq yds	Work Content S.M.'s	Time Taken Hours	Time Lost through Wet Weather Hours
Barrow and lay 1½ in. nominal size coated macadam 3 in. thick	800 Sq. Yds.	460	3,680	135	3
Roll with 10 ton Roller	800 Sq. Yds.	37	296	10	1
		Total	3,976	145	4

Total work content (Productive Standard Hours) $= \frac{3976}{60}$

$= 66 \cdot 3$ PSHs

Total time spent on work sample = 145 actual hours

Total time lost due to wet weather = 4 actual hours

Net time spent on work sample = 141 actual hours

Effective Performance $= \frac{66 \cdot 3}{141} \times 100 = 47$

Target level for an urban district council = 78

Scope for improvement $= \frac{78-47}{47} \times 100 = 66\%$

7. GLOSSARY OF TERMS EMPLOYED

a. Standard Time

This is the time required for a job assuming:—

an average experienced operative;
working over the day or shift at a pace normally used under incentive conditions;
under capable supervision;
allowing for normal fatigue and delay times;
using the correct method;
producing the required quality.

Two units are used, the STANDARD MINUTE (SM) and the STANDARD HOUR (SH).

60 SMs=1 SH

The work content of an operation is expressed in Standard Minutes; they become equal to clock minutes only when the operation is performed under the conditions described above.

b. **Productive Work**

This is work which alters the physical or chemical nature of the product or advances the process as a necessary contribution to its completion. It is measured in Productive Standard Minutes (PSMs) or Hours (PSHs).

c. **Non-Productive Work**

This is work which, although essential, does not contribute directly to the finished job, for example:—transport of materials to the site, maintenance of vehicles. It is measured in Non-Productive Standard Minutes (NPSMs) or Hours (NPSHs).

d. **Effective Performance**

This is the usual control index of productivity and is the ratio of:—

$$\frac{\text{Productive work completed (in PSHs)}}{\text{Time taken (in clock hours)}} \times 100$$

e. **Clock Time (or Actual Time)**

This is the total time spent on a job by a man or group of men.

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Part B: Tables of Standard Times

1. Earthworks

		SMV	Unit
1.1.	SCARIFYING		
1.1.1.	Scarify with heavy roller, clear away and load spoil to lorry (2″–3″ deep).	8·1	Sq. Yd.
1.2.	EXCAVATION		
1.2.1.	*By pneumatic drill and stack aside by hand*		
1.2.1.	(i) Consolidated bituminous materials	126	Cu. Yd.
	(ii) Concrete	183	Cu. Yd.
	(iii) Consolidated hardcore	86	Cu. Yd.
1.2.2.	*By $\frac{5}{8}$ cu. yd hydraulic excavator tractor and stack aside or direct to lorry* (SMV is for driver only, double the value if a banksman is necessary). All soil categories except consolidated bituminous materials, gravel and concrete.		
1.2.2.1.	From trench to aside	4·0	Cu. Yd.
2.	From trench to lorry	6·4	Cu. Yd.
3.	From open ground to aside	3·9	Cu. Yd.
4.	From open ground to lorry	4·5	Cu. Yd.
1.2.3.	*By pick and shovel and stack aside* The SMV depends on the category of soil and the relative depth and width of the excavation. Soil categories are:— A. Top soil B. Wet top soil, medium clay C. Heavy clay, soil and stone D. Consolidated bituminous materials, gravel, concrete.		

Ratio of Depth to Width of the Excavation		Grade of Soil A	B	C	D	
Shallow—Wide	0	50	85	94	115	Cu. Yd.
	·2	54	90	102	127	Cu. Yd.
	·4	58	96	110	138	Cu. Yd.
	·6	62	102	118	150	Cu. Yd.
	·8	66	107	125	161	Cu. Yd.
	1·0	70	113	133	172	Cu. Yd.
	1·2	74	118	141	183	Cu. Yd.
	1·4	77	124	148	194	Cu. Yd.
	1·6	81	130	156	205	Cu. Yd.
	1·8	85	135	164	217	Cu. Yd.
Deep—Narrow	2·0	89	140	173	228	Cu. Yd.

		SMV	Unit
1.3.	BACKFILLING		
1.3.1.	Backfill soil or muck by hand	20	Cu. Yd.
1.3.2.	Backfill soil or muck by hand and consolidate by hand ramming	39	Cu. Yd.
1.3.3.	Backfill heavy clay, gravel, hardcore by hand and consolidate by hand ramming	49	Cu. Yd.
1.3.4.	Spread over pipes, gravel tipped into trench by lorry	4·4	Cu. Yd.
1.3.5.	Consolidate gravel backfilling by hand ramming	10·5	Cu. Yd.
	2. Drainage		
2.1.	PIPEWORK		
	Collect pipes, lay out along line of trench, lower to trench, bottom up, lay in position, check levels:—		
2.1.1.	*6″ Glazed Socket Pipes × 3′*		
	(i) No jointing	4·4	Pipe
	(ii) Joint	11·3	Pipe
	(iii) Joint, lay in concrete pipe bed (includes mixing etc.)	14·3	Pipe
2.1.2.	*9″ Glazed Socket Pipes × 3′*		
	No jointing	4·9	Pipe
2.1.3.	*6″ Land Drains*		
	(i) No checking of levels	2·8	Lin. Yd.
	(ii) Check levels	9·3	Lin. Yd.
	(iii) Cut hole in land drain pipe	13·5	Occasion
2.1.4.	*Concrete Tubes*		
	(i) *BY HAND ONLY*		
	Internal Diameter / Length		
	a. 12″ / 3′	7·3	Tube
	b. 15″ / 3′	9·9	Tube
	c. 12″ / 6′	21·0	Tube
	d. 23″ / 3′	11·2	Tube
	(ii) *ASSISTED BY MACHINE*		
	a. 12″ / 6′	17·2	Tube
	b. 15″ / 6′	32·3	Tube
	c. 27″ / 3′	15·0	Tube
	d. 48″ / 3′	43·5	Tube
	e. 48″ / 6′	180·0	Tube
	f. 27″ / 3′ (curved)	70·5	Tube

		SMV	Unit
2.2.	GULLIES		
2.2.1.	Break out old gully pot and complete excavation for positioning new pot.	281	Occasion
	Lower and position, backfill with soil or gravel, hand ram, fit connecting pipe, fit grid, back up, top with concrete and complete with bituminous material hand rammed. Plus courses of bricks if necessary. (Does not include excavation)	100	Occasion
		+	
		17	Course of bricks
2.3.	CATCHPITS (Area approximately 6 sq. ft.)		
2.3.1.	Construct complete. (Does not include excavation)		
	(i) Using shuttering and concrete	112	Occasion
	(ii) Using 4½″ brickwork	48	Occasion
		+21	Course
2.4.	MANHOLES (Area greater than 12 sq. ft.)		
2.4.1.	Construct complete with 'concrete top'. (Does not include excavation)		
	(i) Using shuttering and concrete	273	Occasion
		+50	Ft. Depth
	(ii) Using 9″ brickwork	134	Occasion
		+41	Course
	(iii) Using 4½″ brickwork	134	Occasion
		+29	Course
2.4.2.	Construct complete with 'iron top'. (Does not include excavation)		
	(i) Using shuttering and concrete	200	Occasion
		+50	Ft. Depth
	(ii) Using 9″ brickwork	61	Occasion
		+41	Course
	(iii) Using 4½″ brickwork	61	Occasion
		+29	Course
2.5.	KERBING		
2.5.1.	*Laying Kerbs*		
	Excavate, mix concrete or receive ready-mix, level and compact, set out, receive, lay, maul PCC* kerbs, level, lay backing and butt		
	(i) on bedding	19	Lin. Yd.
	(ii) on ready mixed concrete	24	Lin. Yd.
	(iii) on hand mixed concrete.	33	Lin. Yd.

*PCC = Pre-cast concrete.

	SMV	Unit
2.5.2. *Relaying Kerbs* Lift old kerb, mix concrete or receive ready-mix, level and compact, set out, receive, lay, maul PCC kerbs, level, lay backing and butt		
(i) on bedding	25	Lin. Yd.
(ii) on ready mixed concrete	32	Lin. Yd.
(iii) on hand mixed concrete.	35	Lin. Yd.
2.5.3. *Other Kerbing Work*		
(i) Lift kerb only and stack aside	14	Lin. Yd.
(ii) Excavate for kerb only	7·8	Lin. Yd.
(iii) Haunch kerb	3·4	Lin. Yd.
(iv) Lay kerb base ready-mix concrete	3·5	Lin. Yd.
(v) Lay kerb base hand-mixed concrete	10·5	Lin. Yd.
(vi) Cut kerb	6	Occasion
2.6. CHANNELS		
2.6.1. *Laying Channels* Excavate for new channels, lay channels, point channels	15	Lin. Yd.
2.6.2. *Relaying Channels* Remove old channels, lay channels, point channels	18	Lin. Yd.

3. Laying Carriageway Materials

3.1. LAYING BITUMINOUS MATERIALS BY HAND

3.1.1. Distribute bituminous materials over site by barrow, spread, level with rake and shovel

Type of Material	Thickness (inches)						
	½	1	1½	2	3	4	
1½″ nominal size coated macadam				380	460	540	100 Sq. Yds.
¾″ nominal size coated macadam			385	385			100 Sq. Yds.
⅜″, ¼″ nominal size coated macadam		330					100 Sq. Yds.
Asphalt	270	295	320	350			100 Sq. Yds.

3.1.2. Spread bituminous materials from closely spaced heaps distributed by lorry, level with rake and shovel

Type of Material	Thickness (Inches) ½	1	1½	2	3	4	SMV	Unit
1½″ nominal size coated macadam				254	307	360		100 Sq. Yds.
¾″ nominal size coated macadam			257	257				100 Sq. Yds.
⅜″, ¼″ nominal size coated macadam		220						100 Sq. Yds.
Asphalt	180	197	213	233				100 Sq. Yds.

3.3. SURFACE DRESSING

Spray binder 7′–8′ wide, spread chippings from lorries, clear grids etc, roll. (Does not include later sweeping of excess chippings.)
Typical gang size:—

- 1 Ganger
- 1 Binder distributor driver
- 1 Spray bar operator
- 3 or 4 Chippings lorry drivers
- 1 or 2 Roller drivers
- 2 Labourers controlling spreading of chippings
- 3 Labourers sweeping, spreading chippings and clearing grids.

Other staff:—

- 1 or 2 Traffic controllers
- 1 Shovel driver to load lorries
- 1 Labourer to trim chippings at dump.

Note: The wide range of conditions under which surface dressing is carried out prevents the establishment of one gang size and one SMV. Work measurement carried out in many authorities has produced a series of SMVs tailored to their particular conditions. The main causes of reduced output are:—

(i) Poor supply of materials.
(ii) Physical obstruction due to narrow roads, parked cars, traffic.
(iii) Length of run restricted by short roads, culs de sac, poor work planning.

Good organisation can minimise the effect of these factors and only in conditions of considerable physical obstruction can any divergence from the lower end of the range of SMVs, listed below, be justified.

		SMV	Unit
3.3.1.	*Good Conditions* Wide roads, easy access for chippings lorries, continuous working	5·0	Per man Per 100 Lin. Yds.
3.3.2.	*Poor Conditions* Narrow roads, poor access for chippings lorries, eg country lane with passing places only, short runs and culs de sac	22·0	Per man per 100 Lin. Yds.
3.3.3.	*Hand Work* Spreading binder and chippings by hand on lay-bys etc.	15·0	Per man per 100 Sq. Yds.
3.4.	CONCRETING—INCLUDING MIXING		
3.4.1.	*Mix and Spread* Mix as appropriate, barrow spread and level concrete. (Does not include reinforcing) Wet Mix		
	(i) Mix by hand	149	Cu. Yd.
	(ii) Mix by $3\frac{1}{2}$–5 cubic feet mixer	77	Cu. Yd.
	(iii) Ready-mix	21	Cu. Yd.
3.4.2.	*Shuttering*		
	(i) Position and fix shuttering	7·8	Lin. Yd.
	(ii) Remove and clean shuttering	9·9	Lin. Yd.
3.4.3.	Float concrete to smooth finish	5·4	Sq. Yd.
3.4.4.	Place reinforcement mesh	0·7	Sq. Yd.
3.5.	LAYING MISCELLANEOUS MATERIALS BY HAND		
3.5.1.	Apply emulsion by brush	81	100 Sq. Yds.
3.5.2.	Apply emulsion by hand sprayer	51	100 Sq. Yds.
3.5.3.	Spread and level hardcore to approximately 9″ unconsolidated thickness	404	100 Sq. Yds.
3.5.4.	Spread and level ashes	107	100 Sq. Yds.

	SMV	Unit
3.5.5. Spread coated grit	45	100 Sq. Yds.
3.5.6. Fit edging boards	171	100 Lin. Yds.

4. Rolling Various Materials

Type of Roller	Type of Material				
	Coated Macadam	Asphalt	Hardcore	Ash	
Heavy diesel 8–12 ton	37	32	51	63	100 Sq. Yds.
Light diesel 1½–2½ ton	46	57			100 Sq. Yds.
Vibrating footpath	69	99	90	71	100 Sq. Yds.
Hand ram	136	136			100 Sq. Yds.

5. Patching, Potholes, Trenches and Boxes

5.1. PATCHING

Prepare patch by picking out unsound metal where necessary, brushing clean, spread material and compact.

Material	Method of Consolidation			
	Hand Ram	Hand Roll	Vibro Roll	
Coated macadam	17·0	12·3	9·3	Sq. Yd.
Coated macadam and fine cold asphalt	21·5	16·3	12·7	Sq. Yd.
Emulsion and fine cold asphalt	8·3	7·1	6·6	Sq. Yd.

Note: These SMVs must not be used for a patch or series of adjacent patches whose total area is greater than 20 sq. yds. SMVs for larger patches should be calculated from the SMV for laying coated macadam in Section 3.1.

5.2. POTHOLES (Small isolated faults)
Brush out, prepare and patch pothole

Material	Up to 5 sq. ft.	6–10 sq. ft.	11–15 sq. ft.	Unit
Emulsion and fine cold asphalt	4·3	11·4	14·6	Pothole
Emulsion and coated macadam	6·0	15·0	20·0	Pothole
Emulsion, coated macadam, fine cold asphalt	7·6	18·0	29·3	Pothole

Note: These SMVs must only be used for isolated potholes. SMVs for patching or coated macadam laying should be used for quantities of adjacent potholes.

5.3. TRENCH REINSTATEMENT
Excavate temporary reinstatement to depth quoted, lay coated macadam or hand pitch hardcore, or mix and lay concrete as necessary, barrow and lay 1½″ nominal size coated macadam, barrow and lay coated macadam wearing course, sweep in fine cold asphalt, roll between layers, load surplus materials.

Total Depth	Materials Used			Unit
	Coated Macadam only	Plus Hardcore	Plus Concrete	
2″	35			Sq. Yd.
4″	42			Sq. Yd.
6″	48	72	80	Sq. Yd.
8″		76	82	Sq. Yd.
10″		81	84	Sq. Yd.
12″		84	86	Sq. Yd.

Note: These SMVs must only be used when complete excavation is carried out. SMVs for patching should be used when only partial cleaning out of loose material is necessary.

		SMV	Unit
5.4.	RELEVELLING OF BOXES Adjusting boxes by raising or lowering during resurfacing work		
5.4.1.	Manhole	170	Occasion
2.	Gully grating	87	Occasion
3.	Hydrant	66	Occasion
4.	Small box	38	Occasion
	6. Footways		
6.1.	FLAG PAVING		
6.1.1.	*Laying Flags* Lay bed, position and lay paving flag, grout in		
	(i) PCC* flags	15	Sq. Yd.
	(ii) York Stone flags	17	Sq. Yd.
6.1.2.	*Relaying Flags* Lift out flag, trim bed, position and lay paving flag, grout in		
	(i) PCC* flags	17	Sq. Yd.
	(ii) York Stone flags	22	Sq. Yd.
	(iii) Blue Bricks	30	Sq. Yd.
6.1.3.	*Cut Flags*		
	(i) Straight cut	5·8	Occasion
	(ii) Curved cut	10·4	Occasion
	(iii) Indent cut	34	Occasion
	(iv) Corner cut	16	Occasion
	(v) Pierce round or square	49	Occasion
6.1.4.	*Other Flag Work*		
	(i) Point front or back line	2·0	Lin. Yd.
	(ii) Lift flag only	3·0	Sq. Yd.

*PCC=Pre-cast concrete.

6.2. VEHICLE CROSSINGS

Construct footway crossing complete in coated macadam or concrete

Length of crossing (along kerb)	Width of pavement excavated to form crossing 2′ SMV	3′ SMV	4′ SMV	5′ SMV	6′ SMV	7′ SMV	8′ SMV	Unit
6′	160	188	212	240	260	280	308	Occasion
7′	185	215	244	274	294	322	356	Occasion
8′	210	245	275	308	329	365	404	Occasion
9′	235	272	307	341	364	408	453	Occasion
10′	260	300	338	375	400	450	501	Occasion

7. Walls

		SMV	Unit
7.1.	BRIC KWALLS		
7.1.1.	Build wall—set up line, lay mortar and bricks, mix mortar by hand	1·57	Brick
2.	Cut out brick and lay new brick	13·8	Brick
3.	Rake out and repoint brickwork	58	Sq. Yd.
5.	Point brickwork	50	Sq. Yd.
7.2.	CONCRETE BLOCK WALLS		
7.2.1.	Build concrete block wall, set up line, lay mortar and blocks. (Does not include pointing or mix mortar)	6·9	Lin. Yd. of course
2.	Point concrete block wall	1·6	Lin. Yd. of course
3.	Add to 7.2.1. for mix mortar by machine	1·3	Lin. Yd. of course
4.	Add to 7.2.1. for mix mortar by hand	1·6	Lin. Yd. of course

8. Grass Cutting, Verges, Ditches, Hedges

			SMV	Unit
8.1.	MOWING AREAS			
8.1.1.	Tractor and 3 gang cylinder mower	84″	1·2	100 Sq. Yd.
2.	Pedestrian-controlled auto-scythe		4·8	100 Sq. Yd.
3.	Cylinder mower (pedestrian-controlled)	30″	3·5	100 Sq. Yd.
4.	Cylinder-mower (pedestrian-controlled)	27″	3·8	100 Sq. Yd.
5.	Cylinder mower (pedestrian-controlled)	24″	4·1	100 Sq. Yd.
6.	Rotary mower (pedestrian-controlled)	24″	7·9	100 Sq. Yd.
7.	Scythe		27	100 Sq. Yd.
8.	Hook		66	100 Sq. Yd.
9.	Rake cuttings into heaps		12	100 Sq. Yd.
10.	Trim edges		20	100 Lin. Yd.
11.	Trim around obstruction (tree or post) by hook		1	Occasion
8.2.	MOWING VERGES Mow verges either single kerbside swathe or full width, including essential travelling between cuts.			
8.2.1.	Mid-mounted reciprocating—single swathe		1·5	100 Lin. Yd.
2.	Mid-mounted reciprocating—multi swathe		2·0	100 Lin. Yd.
3.	Mid-mounted flail mower—single swathe		2·6	100 Lin. Yd.
4.	Mid-mounted flail mower—multi swathe		3·4	100 Lin. Yd.
5.	Rear-mounted flail mower—single swathe		1·2	100 Lin. Yd.
6.	Rear-mounted flail mower—multi swathe		1·4	100 Lin. Yd.

		SMV	Unit
8.3.	TRIMMING VERGES		
8.3.1.	Set out line and cut back grass verge	71	100 Lin. Yd.
2.	Set out line, cut back grass verge and weed path—average quantity of weeds	380	100 Lin. Yd.
3.	Set out line, cut back grass verge and weed path—large quantity of weeds	520	100 Lin. Yd.
4.	Level soil on verge with tractor and grader blade	17	100 Sq. Yd.
5.	Level soil on verge by hand, soil already *in situ*	90	100 Sq. Yd.
6.	Level soil on verge by hand, soil imported and dumped in heaps	150	100 Sq. Yd.
7.	Sow grass seed	23	100 Sq. Yd.
8.4.	DITCHES (3′–4′ wide, 2′–6′ deep)		
8.4.1.	Dig out and regrade ditch by hand	12	Lin. Yd.
2.	Dig out and regrade ditch by $\frac{5}{8}$ cu. yd. hydraulic excavator tractor	6	Lin. Yd.
3.	Clear out heavy undergrowth	2·3	Lin. Yd.
4.	Dig grip or outlet 3′ × 12″ × 6″ approx.	10	Occasion
8.5.	HEDGES		
8.5.1.	Cut back hedge, and burn trimmings 8′ high × 3′ wide	16·5	Lin. Yd.
2.	Cut back hedge and burn trimmings 4′ high × 3′ wide	8·4	Lin. Yd.
	9. Sweeping		
9.1.	MECHANICAL SWEEPING		
9.1.1.	Sweep		
	(i) Mechanical brush sweeper	1·30	100 Lin. Yd.
	(ii) Mechanical suction sweeper	1·41	100 Lin. Yd.
9.1.2.	Travel with brushes raised		
	(i) Mechanical brush sweeper	·33	100 Lin. Yd.
	(ii) Mechanical suction sweeper	·32	100 Lin. Yd.

		SMV	Unit
9.1.3.	Empty at tip	6	Occasion
9.1.4.	Fill water tank	12	Occasion
9.2.	MANUAL SWEEPING		
9.2.1.	Sweep pavement by hand and load refuse to hand cart		
	(i) Town centre	16·5	100 Lin. Yd. of pavement
	(ii) Outer town/country	12·8	
9.2.2.	Rough sweep after surface dressing or winter gritting, includes pick up and load to lorry		
	(i) Areas	22	100 Sq. Yd.
	(ii) Channels	43	100 Lin. Yd.
	(iii) Channel and footway	116	100 Lin. Yd.
	10. Gully Cleansing		
Vehicle:—	Gully emptier 600–800 gallons		
Gang:—	Driver and mate		
10.1.	Lift grid, clean gully, scoop solids manually, flush with water, seal gully, replace grid, load tools etc, travel to next gully		
10.1.1.	Average conditions	6·0	Occasion
2.	Poor conditions	9·5	Occasion
10.2.	Fill water tank	26	Occasion
10.3.	Empty at tip	30	Occasion

Note: A range of SMVs for operation 10.1. of 3.3–13.8 were seen during the investigation. The SMV depends on the local conditions leading to fouling and the frequency of emptying. The SMVs 10.1.1. and 10.1.2. have been selected from the range as typical of most conditions.

11. Road Markings

Note: As the dimensions of most road markings are specified in feet, the units for the SMVs in this section are quoted in feet.

		SMV	Unit
11.1.	CONTINUOUS WHITE LINES		
11.1.1.	Apply 4″ wide hot applied thermoplastic material	7·5	10 Lin. Ft.
11.1.2.	Mark out for painting		
	(i) Straight lines	3·0	10 Lin. Ft.
	(ii) Curved lines	4·5	10 Lin. Ft.
11.1.3.	Paint white lines		
	(i) Over 0″ up to and incl. 3″ wide	14	10 Lin. Ft.
	(ii) Over 3″ up to and incl. 5″ wide	15	10 Lin. Ft.
	(iii) Over 5″ up to and incl. 8″ wide	18	10 Lin. Ft.
11.2.	INTERMITTENT WHITE LINES		
11.2.1.	Apply 4″ wide hot applied thermoplastic material		

	Mark (feet)	Gap (feet)		
(i)	2	1	15	10 Lin. Ft. of plastic
(ii)	2	6	30	10 Lin. Ft. of plastic
(iii)	3	3	17	10 Lin. Ft. of plastic
(iv)	3	15	27	10 Lin. Ft. of plastic
(v)	6	12	22	10 Lin. Ft. of plastic
(vi)	9	3	11	10 Lin. Ft. of plastic
(vii)	9	9	15	10 Lin. Ft. of plastic
(viii)	12	6	12	10 Lin. Ft. of plastic

11.3. LETTERS

11.3.1. Apply letter

Method	Height of Letter (feet) 2	3	4	6	8	SMV	Unit
			SMV				
Hot applied thermoplastic material		8·6	9·4	10·9	14·0		Letter
Mark out, stencil	8·7	9·4	10·2	11·7	15·0		Letter
Mark out, hand paint	7·9	9·8	11·6	15·2	18·8		Letter
Repaint	5·0	6·9	7·0	9·0	11·0		Letter

11.4. ARROWS

11.4.1. Apply 12 foot arrow

Method	Type of Arrow Straight	Curved	Straight + Turn R or L	SMV	Unit
		SMV			
Hot applied thermoplastic material	55	58	68		Arrow
Paint	18	19	24		Arrow

11.5. REFLECTING STUDS—IRON FRAME AND RUBBER INSET TYPE

Installation and Removal

11.5.1.	Mark out position, excavate using compressor, load rubble to lorry, lay new catseye in position and tamp	17	Occasion
11.5.2.	Excavate old reflecting stud frame using compressor, load rubble to lorry, lay asphalt and tamp	6·9	Occasion
11.5.3.	Replace rubbers with new	3·8	Occasion

		SMV	Unit
11.6.	OTHER ROAD STUDS		
Installation and Removal			
11.6.1.	Mark out, cut roadway, mix cement and fit stud	15	Occasion
11.6.2.	Cut out old stud, fill hole with asphalt and tamp	8·3	Occasion
11.7.	ZEBRA CROSSINGS		
11.7.1.	Mark out and lay in thermoplastic	41	Strip
2.	Relay in thermoplastic	19	Strip
3.	Lay in PVC tiles	6·8	Tile
4.	Mark out and paint	26	Strip
5.	Repaint	10	Strip
	12. Street Furniture		
12.1.	Erect road sign (one post) in coated macadam	63	Occasion
12.2.	Erect road sign (one post) in soil and concrete in	32	Occasion
12.3.	Erect road sign (two posts) in coated macadam	76	Occasion
12.4.	Erect road sign (two posts) in soil and concrete in	40	Occasion
12.5.	Erect hydrant post and sign	50	Occasion
12.6.	Erect 6′ × 6′ sign on two posts	180	Occasion
12.7.	Hammer in reflector post	1·5	Occasion
12.8.	Fit sign to existing post	6	Occasion
12.9.	Fit street nameplate to wall (two fixing holes)	77	Occasion
	13. Street Lighting		
13.1.	LAMPS UNDER 15′ HIGH		
	or not requiring a tower—2 man team		
13.1.1.	Renew lamps (Tungsten, Mercury, Sodium)		
	(i) Renew lamp or starter	15	Occasion
	(ii) Renew lamp and starter or lampholder	19	Occasion
13.1.2.	Clean lamps—1 man team	11	Occasion

		SMV	Unit
13.2.	LAMPS OVER 15′ HIGH requiring tower—2 man team		
13.2.1.	Renew lamps (Tungsten, Mercury, Sodium)		
	(i) Renew lamp or starter	27	Occasion
	(ii) Renew lamp and starter or lampholder	30	Occasion
13.2.2.	Clean lamps	27	Occasion
13.3.	BEACONS		
13.3.1.	Renew globe	17	Occasion
2.	Renew lamp	18	Occasion
3.	Renew lamp and lampholder	26	Occasion
4.	Clean	17	Occasion
13.4.	BOLLARDS		
13.4.1.	Renew lamp	11	Occasion
2.	Renew lamp and lampholder	17	Occasion
3.	Clean	10	Occasion
13.5.	CONTROLS AT COLUMN BASE		
13.5.1.	Repair or renew—clock, fuse, capacitor or choke	14	Occasion
13.6.	COLUMNS		
13.6.1.	Erect 15′ galvanised or concrete column, backfill and ram. (Does not include excavation)	31	Occasion
2.	Erect 25′ concrete column, backfill and ram. (Does not include excavation)	42	Occasion

Appendix 5: Outline of a Management Control System for Highway Maintenance

Part I: General

Object

1. To fulfil the requirements set out in Chapter 9 of this report, a control system should provide full information for the planning of future demand for labour, materials, plant and contractors' services. It should then measure the use of these individual resources against estimates; control of total expenditure is not sufficient. The system should identify the deviations from expectations and indicate the person or cause responsible.

Preparatory Tasks

2. Labour, material and plant costs need to be expressed in terms of a measure of work done, eg man hours, unit lengths of kerb laid, hours in use. The decision on these standard units should be made before the installation of the system and kept up to date. It is also necessary to select suitable job units to be costed. Those used with the national time standards in Appendix 4 of this report might usefully be taken as a first basis for this choice. Standard costs per unit should also be calculated. These should be based on achievable levels of performance and usage, not simply on past costs, as to do so would mask the very sources of loss that this system is intended to reveal. Standard labour costs for example should ideally be based on work study.

Annual Task

3. Estimates of inputs, eg labour and materials, and outputs, eg work done, defined in standard units, should be prepared both for the year ahead and for each month. This involves quantifying the work to be done and evaluating it in the standard units. The work to be done should be based on the standards of maintenance agreed by the chief engineer or surveyor and quantified (in the units chosen) by the area engineer to show the total amount of work to be done and the amount for which each supervisor is responsible. Estimates must be realistic; they should not be changed because of non-achievement, unless senior officers are convinced of a fundamental change in circumstances.

Recording Results

4. Actual output and use of resources (indicating outstanding commitments) should be recorded and the following comparisons made:—

actual units of input (labour, plant, etc) with standard units
actual output „ estimated output
actual expenditure „ estimated expenditure

The detail with which *actuals* and *standards* are compared will vary depending on the requirements of different authorities.

Reporting

5. Before control information statements can be prepared a decision must be made about:—

a. *Information required by each officer*

The information needed by each officer will depend on the range of his responsibilities. Only information about matters under his control should be given to him.

b. *The most effective form of presentation*

Control statements must be confined to important items. They should be designed to highlight the relatively small number of vital factors which have a very large influence on expenditure and efficiency. Where computers are used, exception reporting should be employed.

Important factors may include:—
materials usage
efficiency of labour
plant utilisation.

For control statements to be of maximum use to officers they should:—
show results clearly and unambiguously
show their relation to estimates and standards
be prompt
be designed in conjunction with the officer concerned.

Eventually, when more uniformity has been achieved, comparisons with other local authorities could also usefully be shown.

6. Examples 1 to 6 at the end of this Appendix suggest both how reports might be distributed and the form they might take. The distribution and the forms are only illustrative. The important point about forms is the information they contain. Since computers can print out information in any form, authorities should each decide which is most suited to their own organisation.

Part II: Non-Financial Control System

Operation of Non-Financial Control System in Cambridge

7. The control system advocated in this Appendix emphasises the need to provide management information in the most readily understood form. We believe that, at least for lower and middle management, this means presenting information on use of resources rather than in financial terms. We therefore describe here the operation of the control system for highway maintenance in Cambridge where this approach has been adopted.

8. The system is based on an incentive bonus scheme introduced following work study coupled with a system of control and accounting using a computer.

9. The control of labour usage is exercised by the production of a performance index as a by-product of the calculation of the bonus the men have earned. The index expresses target hours as a percentage of actual hours for each job, and for each gang. A further similar calculation is made deducting non-productive time due to such factors as delays for materials. These figures pinpoint the performance of the staff and any waste caused by undue delay—but at no point is finance involved. The calculations are done entirely in hours and this process throws up clearly faults in planning, inefficient working and incorrect targets.

10. The information about hours worked, having been used for the management process, bonus calculations and the preparation of payroll, is further used to produce figures in the form used for accounting and budget control, the latter by exception reporting. The coding arrangements are such that costs of particular jobs will also be printed out if the need is specified before the commencement of the job. All the records are produced in a series of integrated computer programs from the same initial data. Since all the figures produced are mutually consistent, the various results can be used for their different purposes with complete confidence in their reliability.

11. The main point in the control of materials is that the planners who arrange when work is to be done also arrange for the necessary quantity of materials to be available at the site. This is done by calculation from the standard quantities required for various operations. The reporting system reveals whether excess materials have been used, in which case investigation of the cause can be made. The stores accounting process is again expressed in quantities and weekly print-outs show amounts used on expenditure heads or on jobs where, as with wages, this has been specially requested. The main stock of stores is computer controlled, the computer being programmed to indicate by exception re-ordering levels, minimum stock levels and stores ordered but not delivered. Dates of last issue enable obsolete stores to be reviewed. Material prices are average prices calculated by the computer at the same time each new consignment of stock is received. As with labour charges the use of the same initial data to produce accounting and cost records ensures automatic reconciliation with the records used for control.

12. The control of haulage and plant is achieved by examination of the detailed usage statistics produced for each vehicle, showing weekly and cumulatively the hours available and the hours charged so that idle time can be investigated. The hours vehicles are used are again automatically integrated by the computer with the financial records.

13. The cornerstones of this method are:—

a. careful planning and measurement of performance against estimate in simple non-financial units which can be clearly understood and expressed and are not complicated by financial considerations;

b. integration of the control and financial processes so that financial records reflect accurately the results of the control processes.

14. Such a system implies, as would other systems of control, a rapid feedback of information about actual performance to the officers concerned so that remedial action on discrepancies may be taken as soon as possible. The system also depends on the reliability of the performance standards used as the measure of labour efficiency and only authorities which had undertaken work and method studies could be sure that their standard units were really appropriate.

Part III: Plant Control

Introduction

15. A section on plant control is included because of the subject's importance and because of the lack of control in many authorities visited.

Essential Points of Control

16. This Appendix is not concerned either with the choice between several similar machines which may be available for a particular purpose, or between different methods of doing a job using machines different in purpose, or between various combinations of machines. These choices require wider comparisons of cost than we deal with here, and indeed considerations other than cost may enter into the choice. The Appendix deals with the efficient utilisation and costing of plant where the decisions mentioned in the previous sentence have already been made. The vital points at which decisions are necessary or control needs to be exercised are:—

a. the decisions whether to hire or to buy } both covered
b. given a decision to buy, the optimum point of replacement } in Appendix 3
c. the minimising of the idle time of plant held in a depot either for repair or between jobs
d. the minimising of the idle time of plant, probably with its driver and attendants, on the job itself
e. the cost records that need to be kept.

Minimising of Idle Time of Plant held in a depot either for repair or between jobs

17. This is best achieved by programming the time vehicles are required to be in for routine maintenance and available for jobs, and comparing for each vehicle with this estimate the time actually spent on routine maintenance, other maintenance and use on jobs. This is best shown in non-financial terms, but the same information must be used to produce the financial records. What is important is that a particular individual should be charged with the specific duty of examining these comparative statements when they are produced, locating the reason for discrepancies and taking remedial action.

Minimising of the Idle Time of Plant, probably with its driver and attendants, on the job itself

18. Control of the idle time of vehicles on the job presents no great difficulty where programming is operative since work records must show when vehicles are standing. Other forms of plant present difficulties since the problem is to determine whether such plant could be utilised on another job during its idle periods, but it would be administratively complex and expensive to record idle time so as to distinguish such periods from unavoidable idle time spread over a job. Where plant is charged at different rates for working and idle time a daily record will normally be kept but this is insufficient for the purpose. Control must therefore rest on skilled estimates of the time plant is expected to be used on a job and a comparison of the actual outcome with the estimate. The original estimates must be realistic and will probably be best built up using work study techniques, but careful and cost-conscious supervision on the job itself is essential.

Costing Records

19. While we believe that the records for the control of the use of plant should be expressed in hours, cost records of each particular item of plant must be maintained for:—

a. providing realistic rates, be they hourly, daily or weekly, for charges to jobs based on the use shown by the control records outlined above. As a guide, they should be compared with hire charge rates;
b. comparing the operational costs of different plant serving the same purpose;
c. comparing costs of doing jobs by different methods using different items of plant;
d. providing other financial information required for the decision-making outlined above.

20. These accounts should include all expenses relating to the particular items of plant, should be divided between those which vary with time and those which vary with use, and the latter should be related to some suitable unit of output, so that the efficiency of operation can be judged.

General

21. Responsibility for the estimates and comparisons enumerated should be clearly laid on individuals and, as we propose in Chapter 5, there should be central co-ordination of the use of plant by engineers with expertise in operating and maintaining fleets of vehicles and mechanical plant.

Example 1: Performance Control and Reporting

Statement of Reports for Highway Maintenance to be Prepared and Circulation in a Typical Authority

Report	Frequency	Circulation			
		Chief Surveyor	Assistant Surveyor	Divisional Surveyor	Supervisor
Monthly Financial Report (Example 2)	Monthly	√			
Outstanding Work Load (Example 3)	Quarterly	√	√	√	√
Work Study Controls (Example 4)	Monthly	√	√		
	Weekly			√	√
Plant Utilisation (Example 5)	Quarterly		√	√	
Stock Levels	6 monthly		√	√	
Administrative Expenses (Example 6)	Quarterly	√	√		
		4	5	4	2

Note: The degree of detail shown in the various reports will vary according to the responsibilities of the person to whom they are being submitted.

Example 2: Monthly Financial Report

This report should summarise at the various levels the actual achievement compared to the budget and should go only to the County Surveyor (or equivalent). It should show the actual expenditure to date (including outstanding accounts of work done or materials supplied) and the deviation from budget. This deviation should be broken down by the divisions to show who was responsible for the over/under expenditure.

HIGHWAY MAINTENANCE

Date .....

MONTHLY REPORT TO CHIEF SURVEYOR

Actual Expenditure to.....	(including outstanding accounts)	£129,000
VARIANCE—Over/(Under) expenditure as compared with estimate		£(2,000)

RESPONSIBILITY FOR VARIANCES:

WORK LOAD—Volume—more/(less) work performed than budget—Total volume

Division 1	Mr Smith	£(250)
Division 2	Mr Jones	£(1,600)
	etc	£(150)

(All figures are cumulative for the year to date)

FUTURE CASH SITUATION

Balance of monies—(Estimated expenditure for year less spent as above)	£396,000
Less: Outstanding commitments (orders placed for goods or services not yet supplied)	£5,500
AVAILABLE for use	£390,500

Example 3: Future Work Load

(See examples 3.1 to 3.3)

Statements of work load should compare the available labour resources in man days or standard hours with the original estimated requirement and should show the action proposed or agreed. It is suggested that these statements should be prepared at least once a quarter.

The information might be adapted for various levels as follows:—

Chief Officer:	total available and required man-days (standard hours) with deviations shown against the division responsible.
Area Engineers:	standard work under the control of each supervisor showing over (under) capacity of available labour.
Supervisors:	breakdown of over (under) capacity to show on which maintenance functions the deviations are occurring.

Example 3.1

HIGHWAY MAINTENANCE	
Outstanding Work Load of Authority—(date)	Standard Hours
Estimated Work Load outstanding (Per Annual Estimates)	90,000
Add: Planned Increases (Decreases)	(2,000)
TOTAL WORK OUTSTANDING 31.12.69	88,000
TOTAL STANDARD HOURS AVAILABLE TO 31.3.70	90,000
UNDER/(OVER) CAPACITY	(2,000)

RESPONSIBLE FOR UNDER/(OVER) CAPACITY		
Division 1	Mr Smith	200
Division 2	Mr Jones	(1,000)
Division 3	etc	(1,200)

ACTION AGREED

1. Division 2 — Increase work on drainage—as per regional plan (500 Standard Hours).
2. Divisions 2 and 3 — Reduce Labour Force.

Example 3.2

HIGHWAY MAINTENANCE

DIVISION ONE—MR SMITH

Outstanding Divisional Work Load—(date)

	Standard Hours
Estimated Work Load outstanding (Per Annual Estimate)	15,000
Add: Planned Increases (Decreases)	1,000
TOTAL WORK OUTSTANDING 31.12.69	16,000
TOTAL STANDARD HOURS AVAILABLE	15,800
UNDER/(OVER) CAPACITY	200

RESPONSIBLE FOR UNDER/(OVER) CAPACITY

Supervisor	Mr Green	400
Supervisor	Mr Black	(300)
Supervisor	Mr White	100

ACTION AGREED

Transfer gang from Mr Black's to Mr Green's section for 200 hours.

Example 3.3

HIGHWAY MAINTENANCE

SUPERVISOR—MR GREEN

Outstanding Work Load: (date)

Type of Work	Work Outstanding			Gangs			Under Capacity	Action Proposed
	Balance of Annual Estimate	Increase Decrease	Estimated Outstanding	A Blue	B Brown	C Grey		
	Std Hrs	Std Hrs	Std Hrs	Std Hrs	Std Hrs	Std Hrs		
Patching	1,500	+200[1]	1,700	1,200		200	300	Gang B to do less signs work and take on some patching.
Drainage	300	—	300			300	—	
Signs	1,200	—	1,200		1,200		—	
Sweeping	500		500		400		100	Reduce frequency during bad weather.
Grass and Verge Maintenance	750	− 50[2]	700			700		
Resurfacing	400	+100[1]	500			500		
Surface Dressing	—						—	
TOTAL WORK OUTSTANDING	4,650	+250	4,900	1,200	1,600	1,700	400	
		Hours available		1,200	1,600	1,700		
		Over Capacity		—	—	—		

NOTES—[1] Extra work to be done because of excessive frost damage.

[2] Reduction made to compensate partly for above.

Example 4: Specimen Work Study Controls

The detail of the controls and the frequency of their presentation will vary according to whom they are being submitted.

WEEKLY CONTROL SUMMARY

A suitable weekly control summary for a Divisional Surveyor showing the key results for kerb relaying gangs in his division might take the form illustrated in Example 4.1. The following notes should be read in conjunction with the Example:—

1. INDICES

$$\textit{Output} = \frac{\text{standard hours}}{\text{budget standard hours}} \times 100$$

$$\textit{Cost} = \frac{\text{actual unit cost}}{\text{budget unit cost}} \times 100$$

2. DEVIATIONS

Standard hours=difference between actual and budget standard hours. If more standard hours are worked than are budgeted for, this is indicated as a saving because more of the fixed overheads are thereby covered.

Labour This can be derived in two ways:—

a. (Unit cost–budget unit cost) × standard hours worked.
b. Wages–(standard hours worked × budget unit cost).

3. MEMORANDA

The memoranda columns are derived as follows:—

$$\text{EP} = \frac{\text{standard hours}}{\text{total hours (direct and indirect)}}$$ Effective Performance

$$\text{Earnings} = \frac{\text{wages}}{\text{hours (direct and indirect)}}$$ £ per hour worked

$$\text{Unit Cost} = \frac{\text{wages}}{\text{standard hours}}$$ £ per standard hour

$$\text{Work Content} = \frac{\text{standard hours}}{\text{output in lin yd}}$$ standard hour per lin yd

Example 4.1: Weekly Control Summary

WEEKLY CONTROL SUMMARY

Week Ended	Indices		Deviations		Output		Hours	Wages	Memoranda			
	Output	Cost	Std Hrs	Labour £	Linear Yards	Std Hrs	Dir & Ind	Dir & Ind	EP	Earnings	Unit Cost	Work Cont.
Budget	100	100	—	—	512	312	400	£200	78	0·50	0·64	0·61
Last Qtr	107	106	(23)	13	560	335	440	£228	76	0·52	0·68	0·60
5.7.69	96	108	12	16	500	300	400	£208	75	0·52	0·69	0·60
12.7.69	102	100	(8)	—	525	320	400	£204	80	0·51	0·64	0·61
19.7.69	99	103	3	6	500	309	400	£204	77	0·51	0·66	0·62
26.7.69	100	98	—	(4)	518	312	400	£196	78	0·49	0·63	0·60
Average												

Department
No. 3 Division

Section
Kerb Relaying Gang

Example 4.2: Monthly Control Summary

Less detail will be required at Assistant Surveyor level. A monthly control summary for that level might therefore take the following form:—

MONTHLY CONTROL SUMMARY

(4 or 5 week months)

KERB RELAYING GANG NO. 3 DIVISION—1969/70

No. of weeks	Week ending	Output Index	Effective Performance	Earnings £/hour	Cost Index
Budget		100	78	0·53	100
4	26.4.69	96	77	0·52	99
4	24.5.69	94	79	0·54	100
5	28.6.69	99	76	0·52	102
4	26.7.69	99	77	0·51	102
5	30.8.69				
4	27.9.69				
4	25.10.69				
5	29.11.69				
4	27.12.69				
4	24.1.70				
4	21.2.70				
5	28.3.70				

Example 5: Plant Utilisation

For a further discussion of plant control, see paras 15–21 of the introduction to this Appendix. Reports on plant utilisation should be prepared, giving details on each group of plant. Large items of plant should be shown separately.

The information given might show
- —hours available
- —hours worked
- —standard units produced.

Differences between hours available and worked should be analysed to show
- —idle time
- —repair time etc.

Comparisons could be made between the standard units produced and the hours worked to show
- —efficiency of working
- —deviations caused by
  - —wet time
  - —under manning
  - —slow working etc.

Example 6: Administration Expenses

A budget should be made out at the beginning of the year for administration expenditure.

Statements should be prepared to compare actual expenditure with budget, deviations being shown under the officer responsible. They might take the following form:—

HIGHWAY MAINTENANCE

ADMINISTRATION EXPENSES

QUARTER ENDING.....

This Period		Expense	Cumulative	
Actual	Deviation		Actual	Deviation
		CHIEF OFFICER		
		Staff Salaries		
		Specialists' Fees		
		Office Accommodation		
		Training, etc.		
		ASSISTANT SURVEYOR		
		Travelling and Subsistence Expenses		
		Drawing Office Expenses		
		Laboratory Expenses		
		Depot Expenses		
		CHIEF CLERK		
		Postage and Telephone		
		Duplicating, etc.		
		OTHER CHARGES		
		Central Establishment Charges etc.		
		TOTAL ADMINISTRATION EXPENDITURE		

Deviations are the differences between actual and budgeted expenses. The above list of expenses, grouped under the officer responsible for them, is necessarily abbreviated in this example which shows the principles only.

Appendix 6: Planning Charts

1. All highway authorities are now familiar with network programming but in our view this is likely to be too complex an approach for most maintenance operations. We believe that simple charts could provide a valuable aid to efficient planning and programming of maintenance.

2. Two examples of planning and bar charts are presented on the following pages. These are of course no more than examples and authorities should devise their own. Our aim is to emphasise how helpful graphic presentation of programmes or individual operations can be.

Example 1

3. This is a bar-chart for cyclic, structural maintenance. It covers 12 week periods and is designed to be up-dated and modified every six weeks. Similar bar-charts can be devised for non-cyclic maintenance operations.

Example 2

4. We can show only a two-dimensional illustration. When in use however various parts of this chart—gangers' names and coloured blocks for individual jobs—are movable so that adjustments can easily be shown. The chart would normally cover periods far longer than that illustrated. Using plastic strips stuck on to laminated plastic sheets, authorities would find this type of chart easy and inexpensive to make.

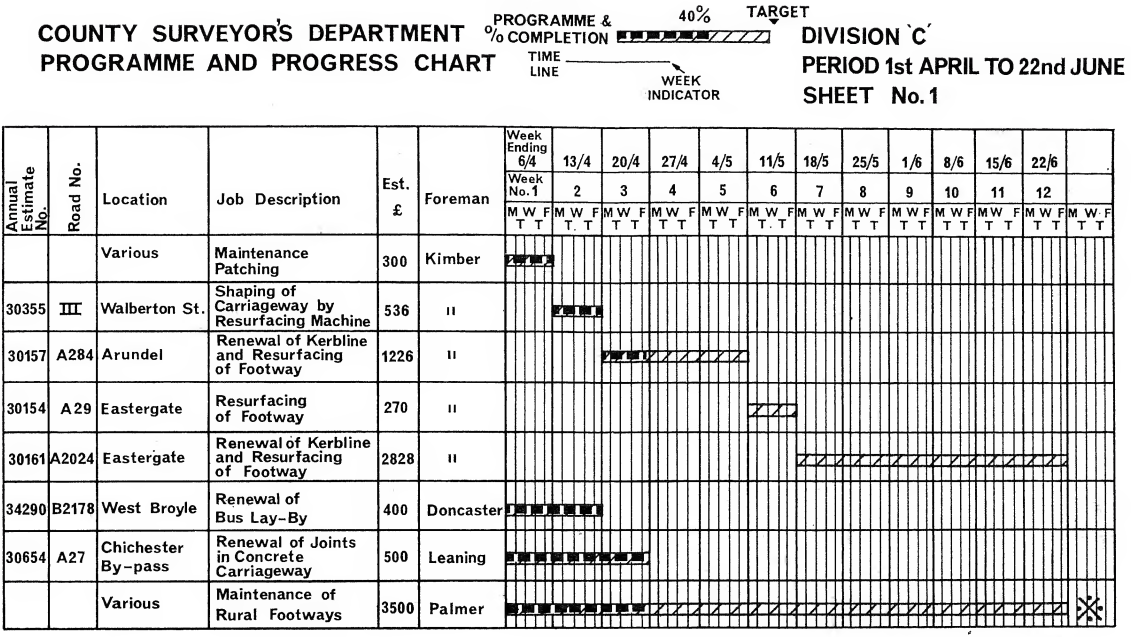


Fig. 2. Programme and Progress Chart

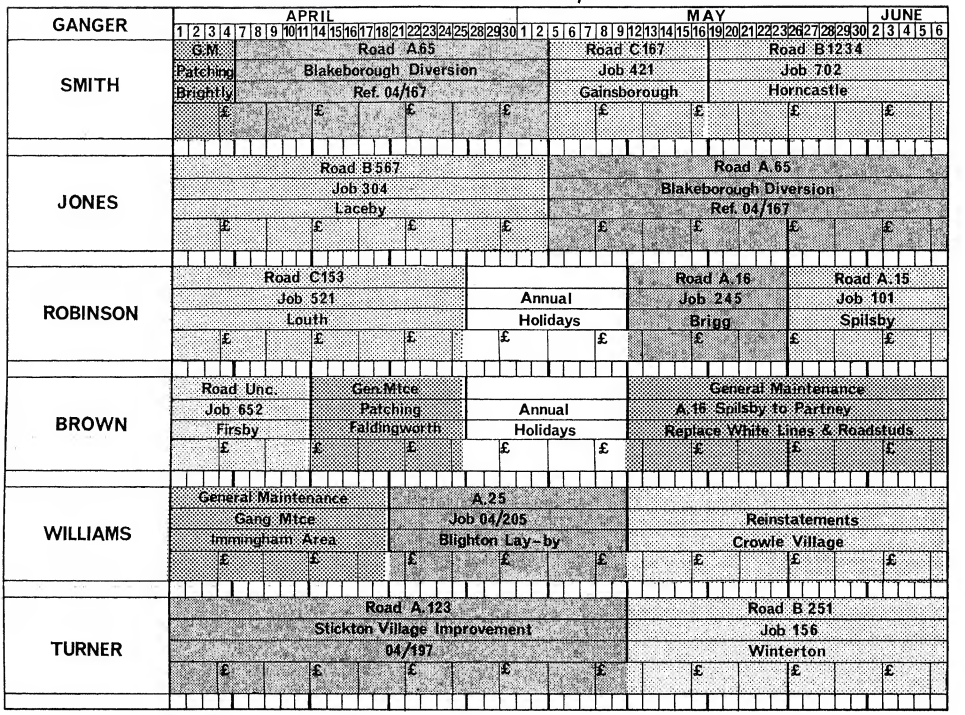


Fig. 3. Gangers' Works Programme

Appendix 7: Data from the Standards Study

Table 1

BRIEF DETAILS OF THE HIGHWAY AUTHORITIES WHICH TOOK PART IN THE ROAD RESEARCH LABORATORY'S STUDY

In these notes, *average* implies average for the 22 authorities studied. *Population density* is the number of persons per mile of road.

Authority A—a large county, predominantly agricultural, very high road mileage with low population density. Low level of resources, mild climate, light traffic.

Authority B—a smallish county, partly agricultural and partly industrial and mining. Below average road mileage but average population density; above average level of resources, mild climate but liable to snow in some parts, medium traffic.

Authority C—an average size county, residential and agricultural in nature, average road mileage and population density, average level of resources, mild climate, medium traffic.

Authority D—a large county, mainly agricultural but with some heavy industry. High road mileage with a low population density and low level of resources. The climate is a little more extreme than the average but rainfall is moderate; traffic generally medium.

Authority E—a large county, half heavily industrial and half agricultural, with a high road mileage, high population and a high level of resources. The climate is damp and parts are very liable to snow; heavy traffic.

Authority F—an average size county, mainly agricultural but with large residential areas, average road mileage and population density and average level of resources. The climate is generally mild but parts are liable to snow. Medium to heavy traffic.

Authority G—a rather above average size county, partly agricultural and partly industrial with mining and quarrying, average road mileage, population density and level of resources. Climate is moderate and traffic heavy.

Authority H—a very large partly wild, partly agricultural county with average road mileage, very low population density and low level of resources. The climate is moderate to harsh and the traffic is light.

Authority J—a large, barren county with below average road mileage, very low population density and very low level of resources. The climate is moderate to harsh and the traffic very light.

Authority K—a small municipal borough, commercial and residential, rather below average road mileage for its size with an above average population density and rather low level of resources. The climate is mild and the traffic light.

Authority L—a large urban authority, industrial and residential, road mileage average for its size with a high population density and high level of resources. Climate is mild and traffic very heavy.

Authority M—an above average size municipal borough, with heavy industry, rather above average road mileage for its size giving about average population density and moderate level of resources. The climate is a little more extreme than the average but rainfall is moderate and traffic is medium.

Authority N—an average size county borough, industrial and residential, with average road mileage for those characteristics and average population density, and a high level of resources. Climate is moderate and the traffic heavy.

Authority P—an average size county borough, more residential than industrial, with average road mileage for the conditions and average population density and an average level of resources. The climate is mild and damp and traffic is light to medium.

Authority Q—a small county borough, mainly industrial, with average road mileage for the conditions and average population density, and an average level of resources. The climate is damp and the traffic heavy.

Authority R—a large county borough, industrial and residential, with a rather high road mileage but average population density and a high level of resources. Moderate climate and heavy traffic.

Authority S—a small borough, industrial and residential, with normal road mileage for these conditions and average population density and average level of resources. Mild climate and light to medium traffic.

Authority T—a large urban district having both residential and agricultural areas, with an average road mileage for the conditions and average population density but a low level of resources. The climate is mild and the traffic medium to heavy.

Authority U—a small county borough, industrial and residential, with average road mileage, average population density and average level of resources. The climate is mild but damp and the traffic light to medium.

Authority V—a compact urban district, mainly residential but adjoins industrial areas, average road mileage but with a high population density and above average level of resources. Climate is rather damp and the traffic medium to heavy.

Authority W—a small urban district, residential and a holiday resort, responsible only for district roads. Mild climate and light traffic.

Authority X—a large urban district, mainly residential but has some light industry and agriculture, the normal road mileage for these conditions but above average population density and a below average level of resources. The climate is mild and the traffic medium to heavy.

Table 2

Expenditure on all maintenance functions

	Authority	Motorways		Trunk Roads		Class I roads		Class II roads		Class III roads		Unclassified roads	
		per 1,000 vehicle miles	per mile	per 1,000 vehicle miles	per mile	per 1,000 vehicle miles	per mile	per 1,000 vehicle miles	per mile	per 1,000 vehicle miles	per mile	per 1,000 vehicle miles	per mile
Rural	A	—	—	390	£2,968	200	£991	365	£620	700	£347	1,600	£193
	B	85	£1,923	415	£2,612	510	£1,882	1,055	£1,412	3,495	£628	3,020	£341
	C	—	—	61	£726	60	£530	146	£405	493	£265	510	£202
	D	—	—	170	£2,010	245	£1,182	625*	£798*	675*	£474*	675*	£276*
	E	80	£2,515	97*	£2,505*	427*	£2,573*	722*	£1,872*	1,452*	£1,053*	1,172*	£463*
	F**	65	£1,510	275	£2,580	525*	£2,443*	350*	£1,241*	570*	£696*	1,155*	£516*
	G	34	£839	125	£1,411	120	£673	129*	£606*	259*	£331*	944*	£183*
	H	—	—	305	£1,421	435	£881	625	£467	1,160	£289	1,785	£232
	J	—	—	250	£1,117	280	£531	915	£690	2,010	£503	1,135	£146
Urban	K	—	—	1,300	£3,910	175	£1,420	599*	£2,308*	2,392*	£3,148*	690	£930
	L	—	—	151*	£4,049*	475*	£4,718*	425*	£3,216*	445*	£2,737	1,045*	£2,218*
	M	—	—	205*	£2,864*	200*	£1,651*	380*	£1,659*	1,070*	£2,020*	415*	£794*
	N	—	—	—	—	435*	£3,983*	395*	£1,696*	740*	£1,617*	400*	£903*
	P**	—	—	×	×	630*	£2,415*	710*	£2,401*	895*	£1,407*	890*	£1,441*
	Q	—	—	—	—	←		680	£2,216	→			
	R	—	—	165	£3,280	310	£3,570	550	£2,556	1,360	£2,417	770	£1,244
	S	—	—	—	—	150	£1,474	190	£1,020	380	£1,928	815	£1,047
	T	—	—	86*	£2,544*	116*	£1,185*	106*	£934*	205*	£825*	650*	£927*
	U	not accounted for separately		—	—	595*	£3,088*	585*	£2,208*	490*	£1,668*	1,140*	£2,168*
	V	—	—	105	£2,844	140	£2,180	120	£1,254	585	£1,420	1,190	£1,100
	W	—	—	—	—	—	—	—	—	—	—	1,168	£1,279
	X	—	—	74	£2,238	←		90	£912	→		875	£1,118

*Approximations. These have been made where authorities do not break down all expenditure between different classes of road.

**One year only.

Expenditure shown under Class I Roads.

Note: Expenditure figures for total maintenance and resurfacing (except those for authority C) in Tables 2, 3 and 4 of this Appendix include expenditure on reconstruction and minor improvements.

Table 3.1

Relative expenditure (expressed as a percentage) on individual maintenance functions on trunk roads

	Authority	Resurfacing (a)	Surface dressing (b)	Patching (c)	Snow clearance (d)	Grass cutting (e)	Sweeping (f)	Gully emptying (g)	Kerbs and Footways (h)	Markings etc. (j)	Bridges (k)	Road lighting (l)	Miscellaneous (m)	General Maintenance (n)
Rural	A	73·8	2·4	3·6	2·6	2·2	2·2	0·5	0·4	5·9	0·9	1·5	4·0	—
	B	47·8	2·3	—	4·1	—	—	—	—	6·9	Neg	5·4	7·8	25·7
	C	27·0	11·7	6·1	21·9	12·0	3·3	2·2	—	14·3	0·4	1·1	—	—
	D	63·1	3·2	4·5	7·4	2·4	1·7	3·5	3·8	6·5	2·4	1·2	0·3	—
	E	17·5	3·9	8·3	11·0	14·4	5·7	5·5	10·1	13·2	3·1	0·9	6·5	—
	F	65·1	1·2	—	3·1	1·3	1·4	1·2	—	4·3	—	1·9	—	20·5
	G	44·3	3·2	4·0	12·5	7·7	2·5	2·0	4·4	9·7	0·1	9·6	—	—
	H	41·8	2·7	—	10·9	—	—	—	—	4·2	0·8	1·7	—	37·9
	J	7·8	12·2	—	17·9	—	2·3	—	—	3·2	—	1·4	—	55·2
Urban	K	18·5	—	13·8	1·8	4·4	17·8	—	6·9	14·9	—	14·9	—	6·9
	L	9·6	0·5	—	5·0	8·1	16·0	1·9	13·6	16·9	Neg	28·4	—	—
	M	56·0	2·8	—	1·6	6·5	4·3	0·9	—	—	—	8·1	—	19·8
	N	—	—	—	—	—	—	—	—	—	—	—	—	—
	P	—	—	—	—	—	—	—	—	—	—	—	—	—
	Q	—	—	—	—	—	—	—	—	—	—	—	—	—
	R	39·6	—	16·8	10·7	5·5	4·5	0·8	—	14·7	—	7·4	—	—
	S	—	—	—	—	—	—	—	—	—	—	—	—	—
	T	10·9	1·2	—	3·5	9·4	19·7	5·3	14·8	14·8	—	20·4	—	—
	U	—	—	—	—	—	—	—	—	—	—	—	—	—
	V	←——30·3——→		6·8	3·8	5·8	2·7	2·9	8·6	18·0	—	21·1	—	—
	W	←——Not responsible for trunk roads——→												
	X	—	6·7	—	3·3	10·4	19·4	0·6	—	14·0	—	24·6	—	21·0

Neg=Negligible.

Note: Motorway expenditure is not included.

Table 3:2

Relative expenditure (expressed as a percentage) on different maintenance functions on Class I roads

	Authority	Resurfacing (a)	Surface dressing (b)	Patching (c)	Snow clearance (d)	Grass cutting (e)	Sweeping (f)	Gully emptying (g)	Kerbs and Footways (h)	Markings etc. (j)	Bridges (k)	Road lighting (l)	Miscellaneous (m)	General Maintenance (n)
Rural	A	55·5	8·0	5·5	5·3	5·6	3·0	0·9	0·6	5·6	1·5	1·8	6·7	—
	B	48·5	3·0	—	2·7	—	—	—	—	5·0	0·5	0·2	5·0	35·1
	C	12·5	25·0	8·9	17·7	12·5	4·0	2·6	—	14·9	0·4	1·5	—	—
	D	47·1	6·3	7·9	10·0	2·8	3·1	2·6	5·4	6·4	1·6	6·1	0·7	—
	E	19·5	4·1	4·8	9·3	11·3	5·8	5·7	11·0	6·0	9·3	0·9	12·3	—
	F	68·2	2·4	—	2·0	1·1	1·0	0·6	—	3·1	—	2·3	—	19·4
	G	30·2	6·2	6·2	22·2	9·2	5·2	2·3	4·5	10·5	0·1	3·4	—	—
	H	37·0	5·8	—	10·6	—	—	—	—	3·0	1·1	2·7	—	39·8
	J	32·3	12·4	—	12·2	—	0·1	—	—	—	—	0·3	4·9	37·8
Urban	K	12·6	—	12·5	2·3	7·5	←——14·6——→		6·2	8·5	—	29·6	—	6·2
	L	21·9	—	—	3·1	6·8	13·7	1·6	22·3	14·5	Neg	16·1	—	—
	M	23·9	3·0	—	4·5	1·6	20·4	1·5	—	—	—	14·0	—	31·1
	N	67·3	1·3	7·3	9·2	—	—	1·0	8·5	1·3	0·7	3·4	—	—
	P	22·1	—	—	0·1	8·1	13·4	0·9	—	1·3	—	14·9	—	39·2
	Q	52·9	—	1·0	1·5	1·4	9·9	1·7	—	2·4	Neg	13·8	—	15·4
	R	23·0	2·9	10·9	6·1	1·3	22·8	1·7	included under (a) and (c)	19·5	0·5	11·3	—	—
	S	9·3	2·2	—	5·4	—	29·8	0·8	2·5	4·4	0·6	8·2	21·2	12·6
	T	6·8	12·6	—	7·0	12·8	22·6	7·3	8·7	8·5	—	13·7	—	—
	U	—	—	—	0·7	1·5	←——13·9——→		—	2·3	—	21·4	—	60·2
	V	←——47·4——→		8·5	3·8	7·1	4·9	2·3	10·2	5·2	—	10·6	—	—
	W	←——Not responsible for Class I roads——→												
	X	—	5·1	—	4·1	13·6	12·3	0·4	—	7·5	—	22·6	—	34·4

Neg=Negligible

Table 3:3

Relative expenditure (expressed as a percentage) on different maintenance functions on Class II roads

	Authority	Resurfacing (a)	Surface dressing (b)	Patching (c)	Snow clearance (d)	Grass cutting (e)	Sweeping (f)	Gully emptying (g)	Kerbs and Footways (h)	Markings etc. (j)	Bridges (k)	Road lighting (l)	Miscellaneous (m)	General Maintenance (n)
Rural	A	44·5	14·5	7·1	5·3	7·7	3·3	0·9	0·7	5·8	0·6	1·7	7·7	—
	B	53·3	5·9	—	4·0	—	—	—	—	2·1	0·1	Neg	5·0	29·6
	C	17·5	19·3	9·4	19·7	11·8	5·4	3·5	—	11·6	0·1	2·0	—	—
	D	47·9	8·2	7·3	7·3	3·6	3·9	3·6	7·6	5·6	2·5	1·6	0·9	—
	E	13·9	7·1	6·3	10·7	12·9	7·7	6·7	16·7	5·8	3·0	1·2	8·0	—
	F	46·9	5·3	—	3·6	1·7	1·5	0·9	—	4·3	—	4·0	—	31·8
	G	31·1	11·4	6·9	20·1	6·8	4·6	2·0	6·9	7·1	0·3	2·8	—	—
	H	39·5	10·1	—	10·2	—	—	—	—	0·4	0·7	1·6	—	37·5
	J	20·0	11·7	—	6·3	—	—	—	—	—	—	Neg	—	62·0
Urban	K	45·0	—	12·3	4·1	1·4	←——10·0——→		6·1	1·4	—	13·6	—	6·1
	L	13·8	—	—	6·2	5·3	20·0	3·4	19·6	8·2	Neg	23·5	—	—
	M	20·4	4·5	—	4·2	1·8	22·6	1·9	—	—	—	14·0	—	30·6
	N	16·3	13·1	21·6	21·7	—	—	2·4	13·8	3·1	Neg	8·0	—	—
	P	45·5	—	—	0·1	5·0	10·5	0·7	—	1·0	—	11·4	—	25·8
	Q	←——NO DATA See Class I Roads——→												
	R	9·7	4·7	12·6	9·0	0·4	33·8	2·3	included under (a) and (e)	11·6	0·5	15·4	—	—
	S	5·9	4·9	—	5·9	—	14·8	0·9	4·7	1·8	—	18·6	19·4	23·1
	T	5·4	10·9	—	3·3	13·7	17·6	7·0	18·2	6·6	—	17·3	—	—
	U	—	—	—	0·9	2·1	←——19·4——→		—	3·3	—	29·8	—	44·5
	V	←——38·8——→		5·7	7·2	7·2	5·0	5·7	11·8	5·1	—	12·5	—	—
	W	Not responsible for Classified Roads												
	X	←——NO DATA See Class I Roads——→												

Neg=Negligible

Table 3:4

Relative expenditure (expressed as a percentage) on different maintenance functions on Class III roads

	Authority	Resurfacing (a)	Surface dressing (b)	Patching (c)	Snow clearance (d)	Grass cutting (e)	Sweeping (f)	Gully emptying (g)	Kerbs and Footways (h)	Markings etc. (j)	Bridges (k)	Road lighting (l)	Miscellaneous (m)	General Maintenance (n)
Rural	A	44·7	15·3	7·8	4·1	13·1	4·2	0·8	0·8	1·6	0·5	0·6	6·5	—
	B	46·3	6·7	—	4·3	—	—	—	—	0·9	0·2	0·3	2·9	37·6
	C	12·5	3·3	12·4	14·3	14·3	4·5	2·6	—	2·3	0·8	3·0	—	—
	D	50·2	13·3	9·9	4·9	3·0	3·6	2·7	5·7	1·5	1·9	2·7	0·6	—
	E	15·2	9·8	7·2	10·2	14·1	5·4	9·6	12·4	3·0	3·4	2·2	7·5	—
	F	19·6	10·0	—	2·7	2·6	1·6	0·9	—	1·9	—	7·2	—	53·5
	G	26·1	16·3	8·8	17·8	8·5	6·3	2·1	6·3	2·1	5·1	0·6	—	—
	H	34·7	15·4	—	9·2	—	—	—	—	0·1	0·6	0·4	—	39·6
	J	26·4	11·4	—	9·6	—	—	—	—	—	—	0·3	—	52·3
Urban	K	43·1	—	12·7	1·5	2·6	←13·6→		6·4	3·9	—	9·8	—	6·4
	L	12·7	0·7	—	4·3	2·7	23·5	2·5	20·3	5·6	Neg	27·7	—	—
	M	50·0	3·0	—	2·3	1·0	11·1	1·2	—	—	—	11·3	—	20·1
	N	24·6	3·6	10·4	22·7	—	—	2·5	24·6	3·3	—	8·3	—	—
	P	72·5	2·8	—	0·1	0·7	6·8	0·5	—	0·7	—	7·4	—	8·5
	Q	← NO DATA See Class I Roads →												
	R	16·2	2·7	9·5	7·3	2·3	27·4	2·6	included under (a) and (c)	14·2	1·1	16·7	—	—
	S	2·6	2·1	—	3·0	—	28·0	0·6	2·4	2·9	—	7·0	46·4	5·0
	T	11·0	9·8	—	3·0	10·9	21·9	7·9	10·7	5·1	—	19·7	—	—
	U	—	—	—	1·3	2·8	←25·6→		—	4·4	—	39·5	—	26·4
	V	←26·0→		6·1	7·6	4·5	8·1	3·1	26·3	6·8	—	11·5	—	—
	W	Not responsible for Classified Roads												
	X	← NO DATA See Class I Roads →												

Neg=Negligible

Table 3:5

Relative expenditure (expressed as a percentage) on different maintenance functions on Unclassified Roads

	Authority	Resurfacing (a)	Surface dressing (b)	Patching (c)	Snow clearance (d)	Grass cutting (e)	Sweeping (f)	Gully emptying (g)	Kerbs and Footways (h)	Markings etc. (j)	Bridges (k)	Road lighting (l)	Miscellaneous (m)	General Maintenance (n)
Rural	A	33·6	17·5	10·0	2·7	19·3	5·7	0·8	1·1	0·5	0·6	1·5	6·7	—
	B	30·5	11·1	—	3·5	—	—	—	—	0·3	0·3	2·3	2·9	49·1
	C	26·1	26·2	11·9	5·0	18·8	5·0	1·5	—	1·0	0·5	4·0	—	—
	D	30·7	14·5	20·6	2·5	4·0	5·1	4·7	8·3	1·5	2·5	4·7	0·7	—
	E	11·6	14·5	8·6	4·1	14·6	8·4	11·6	13·3	1·1	3·4	4·9	3·9	—
	F	2·9	10·1	—	1·5	3·3	2·7	2·1	—	1·4	—	9·7	—	66·3
	G	10·4	19·3	13·2	11·0	12·1	8·8	5·5	8·2	1·1	1·1	9·3	—	—
	H	24·4	14·0	—	6·5	—	—	—	—	0·1	1·2	2·2	—	51·6
	J	8·1	18·2	—	5·9	—	—	—	—	—	—	3·3	—	64·8
Urban	K	4·2	2·1	16·2	0·6	12·0	←18·1→		8·2	3·3	—	27·1	—	8·2
	L	6·9	2·7	—	0·7	3·5	29·1	3·2	18·1	1·7	Neg	34·1	—	—
	M	8·7	5·0	—	1·3	6·3	19·9	3·8	—	—	—	29·1	—	25·9
	N	5·5	0·9	18·8	40·8	—	—	4·5	8·7	5·9	—	14·9	—	—
	P	21·7	31·3	—	0·1	2·5	11·8	0·8	—	1·1	—	12·9	—	17·8
	Q	← NO DATA See Class I Roads →												
	R	12·9	5·6	24·1	3·7	2·4	13·9	4·4	included under (a) and (c)	3·9	0·3	28·8	—	—
	S	2·7	3·3	—	2·3	—	42·5	1·1	4·1	0·9	—	28·2	9·4	5·5
	T	13·9	7·8	—	0·7	12·8	17·6	6·0	22·3	1·5	—	17·4	—	—
	U	—	—	—	1·0	2·1	←19·7→		—	3·4	—	30·3	—	43·5
	V	←9·0→		2·4	1·3	2·5	20·0	6·1	12·4	1·6	—	44·7	—	—
	W	21·4	—	—	—	—	←19·5→		—	2·7	—	20·7	—	35·7
	X	—	4·9	—	1·1	14·1	15·0	1·5	—	3·3	—	17·8	—	42·3

Neg=Negligible

Table 4:1

Relative expenditure on highway maintenance for structural maintenance and for aids to movement and safety and amenity purposes, on motorways and trunk roads

		Motorways									Trunk roads								
		Structure			Movement and Safety			Amenity			Structure			Movement and Safety			Amenity		
	Authority	Pence per 1000 veh-mile	Per mile	Cost ratio	Pence per 1000 veh-mile	Per mile	Cost ratio	Pence per 1000 veh-mile	Per mile	Cost ratio	Pence per 1000 veh-mile	Per mile	Cost ratio	Pence per 1000 veh-mile	Per mile	Cost ratio	Pence per 1000 veh-mile	Per mile	Cost ratio
Rural	A*	—	—	—	—	—	—	—	—	—	320	£2429	1	38	£290	0·1	18	£130	0·1
	B*	1	£14	1	48	£1232	88·0	Not known		—	210	£1311	1	68	£426	0·3	Not known		
	C	—	—	—	—	—	—	—	—	—	28	£344	1	25	£271	0·8	9	£111	0·3
	D	—	—	—	—	—	—	—	—	—	140	£1612	1	26	£307	0·2	7	£83	0·1
	E*	31	£957	1	24	£754	0·6	9	£297	0·3	47	£1300	1	29	£629	0·5	18	£502	0·4
	F*	1	£15	1	35	£792	53·0	8	£167	11·2	187	£1742	1	26	£242	0·1	8	£69	0·04
	G	Neg	£12	1	14	£346	29·0	17	£410	34·0	71	£818	1	40	£450	0·5	13	£145	0·2
	H*	—	—	—	—	—	—	—	—	—	142	£646	1	52	£237	0·4	Not known		
	J*	—	—	—	—	—	—	—	—	—	49	£233	1	56	£262	1·1	6	£27	0·2
Urban	K*	—	—	—	—	—	—	—	—	—	510	£1540	1	410	£1236	0·8	285	£867	0·6
	L	—	—	—	—	—	—	—	—	—	27	£1036	1	45	£2039	2·0	78	£974	0·9
	M*	—	—	—	—	—	—	—	—	—	87	£1712	1	72	£276	0·2	16	£309	0·2
	N	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	P	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	Q	—	—	—	—	—	—	—	—	—	← See Class II →								
	R	—	—	—	—	—	—	—	—	—	95	£1876	1	55	£1072	0·6	16	£327	0·2
	S	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	T	—	—	—	—	—	—	—	—	—	28	£820	1	33	£982	1·2	25	£742	0·9
	U	—	—	—	—	—	—	—	—	—	← Data not sufficiently detailed →								
	V	—	—	—	—	—	—	—	—	—	51	£1383	1	45	£1221	0·9	9	£240	0·2
	W	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	X*	—	—	—	—	—	—	—	—	—	6	£163	1	30	£938	5·7	22	£668	4·1

*Cost ratios in these authorities are approximate since some expenditure is shown under 'Miscellaneous' or 'General Maintenance' and cannot be divided between the three groups.

Neg = Negligible.

Table 4:2

Relative expenditure on highway maintenance for structural maintenance and for aids to movement and safety and amenity purposes on Class I and Class II roads

		Class I Roads									Class II Roads								
		Structure			Movement and Safety			Amenity			Structure			Movement and Safety			Amenity		
	Authority	Pence per 1000 veh-mile	Per mile	Cost ratio	Pence per 1000 veh-mile	Per mile	Cost ratio	Pence per 1000 veh-mile	Per mile	Cost ratio	Pence per 1000 veh-mile	Per mile	Cost ratio	Pence per 1000 veh-mile	Per mile	Cost ratio	Pence per 1000 veh-mile	Per mile	Cost ratio
Urban	A*	143	£714	1	26	£125	0·2	17	£85	0·1	213	£423	1	60	£79	0·2	53	£70	0·2
	B*	267	£978	1	41	£149	0·1	Not known			628	£839	1	65	£87	0·1	Not known		
	C	29	£262	1	22	£181	0·7	9	£87	0·3	72	£200	1	49	£135	0·7	25	£70	0·3
	D	172	£837	1	45	£265	0·3	15	£71	0·1	476	£615	1	99	£116	0·2	47	£60	0·1
	E*	273	£1687	1	71	£417	0·2	49	£296	0·2	433	£1116	1	126	£331	0·3	105	£271	0·2
	F*	355	£1743	1	66	£176	0·1	10	£49	0·03	170	£657	1	67	£150	0·2	10	£39	0·1
	G	58	£333	1	44	£243	0·7	17	£97	0·3	70	£355	1	47	£182	0·5	14	£69	0·2
	H*	190	£386	1	71	£145	0·4	Not known			318	£237	1	73	£55	0·2	Not known		
	J*	124	£237	1	35	£67	0·3	Neg	£1	—	293	£221	1	58	£44	0·2	Not known		
Rural	K*	55	£446	1	70	£574	1·2	38	£313	0·7	317	£1478	1	193	£434	0·3	57	£260	0·2
	L	105	£2161	1	89	£1591	0·7	87	£966	0·4	71	£1181	1	78	£1219	1·3	82	£816	0·7
	M*	43	£469	1	77	£306	0·6	32	£365	0·8	97	£445	1	85	£301	0·7	88	£304	0·7
	N	245	£3427	1	190	£556	0·2	Not known			205	£1140	1	190	£556	0·5	Not known		
	P*	75	£474	1	212	£409	0·9	205	£547	1·2	140	£642	1	212	£409	0·6	212	£506	0·8
	Q*	← See Class II →									380	£1430	1	120	£391	0·3	77	£252	0·2
	R	120	£1396	1	115	£1316	0·9	74	£856	0·6	170	£762	1	200	£921	1·2	185	£872	1·1
	S*	23	£227	1	26	£259	1·2	50	£490	2·2	31	£168	1	50	£269	1·6	28	£151	0·9
	T	27	£419	1	62	£346	0·8	27	£420	1·0	28	£387	1	56	£255	0·7	21	£292	0·8
	U	← Data not sufficiently detailed →																	
	V	95	£1489	1	27	£428	0·3	17	£259	0·2	76	£789	1	30	£313	0·4	15	£153	0·2
	W	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	X*	6	£51	1	31	£314	6·2	21	£237	4·7	6	£51	1	31	£314	6·2	21	£237	4·7

*Same remarks as for Table 4.1.

Table 4:3

Relative expenditure on highway maintenance for structural maintenance and for aids to movement and safety and amenity purposes on Class III and Unclassified roads

		Class III Roads									Unclassified Roads								
		Structure			Movement and Safety			Amenity			Structure			Movement and Safety			Amenity		
	Authority	Pence per 1000 veh-mile	Per mile	Cost ratio	Pence per 1000 veh-mile	Per mile	Cost ratio	Pence per 1000 veh-mile	Per mile	Cost ratio	Pence per 1000 veh-mile	Per mile	Cost ratio	Pence per 1000 veh-mile	Per mile	Cost ratio	Pence per 1000 veh-mile	Per mile	Cost ratio
Rural	A*	490	£243	1	44	£22	0·1	120	£60	0·2	1015	£123	1	76	£9	0·1	400	£48	0·4
	B*	405	£334	1	195	£35	0·1	Not known			1265	£143	1	190	£21	0·1	Not known		
	C	302	£161	1	84	£52	0·3	92	£50	0·3	337	£133	1	34	£20	0·1	121	£48	0·4
	D	565	£397	1	63	£43	0·1	44	£31	0·1	555	£225	1	47	£24	0·1	63	£25	0·1
	E*	940	£671	1	205	£163	0·2	350	£250	0·4	805	£307	1	72	£47	0·1	300	£122	0·4
	F*	175	£211	1	67	£83	0·4	24	£29	0·1	190	£78	1	75	£67	0·9	74	£31	0·4
	G	155	£199	1	65	£83	0·4	38	£49	0·2	590	£105	1	140	£39	0·4	210	£38	0·4
	H*	585	£146	1	110	£28	0·2	Not known			705	£93	1	155	£20	0·2	Not known		
	J*	765	£190	1	200	£51	0·3	Not known			290	£38	1	105	£14	0·4	Not known		
Urban	K*	1540	£1959	1	298	£479	0·2	399	£508	0·3	215	£287	1	215	£289	1·0	210	£280	1·0
	L	100	£992	1	78	£1028	1·0	80	£721	0·7	600	£683	1	99	£811	1·2	145	£724	1·1
	M*	610	£1093	1	96	£278	0·2	135	£245	0·2	85	£139	1	76	£241	1·7	125	£208	1·5
	N	550	£1061	1	190	£556	0·5	Not known			210	£347	1	190	£556	1·6	Not known		
	P*	150	£198	1	210	£409	2·1	200	£372	1·9	69	£100	1	210	£409	4·1	230	£415	4·1
	Q*	← See Class II →																	
	R	435	£775	1	520	£925	1·2	400	£717	0·9	365	£589	1	280	£452	0·8	130	£203	0·3
	S*	28	£146	1	48	£248	1·7	105	£540	3·7	92	£117	1	255	£329	2·8	345	£446	3·8
	T	75	£325	1	67	£229	0·7	63	£271	0·8	360	£463	1	66	£180	0·4	225	£282	0·6
	U	← Data not sufficiently detailed →																	
	V	360	£873	1	150	£368	0·4	74	£178	0·2	350	£328	1	570	£525	1·6	265	£247	0·7
	W	← Data not sufficiently detailed →																	
	X*	6	£51	1	31	£314	6·2	21	£237	4·7	56	£72	1	195	£249	3·5	255	£324	4·5

*Same remarks as for Table 4.1.

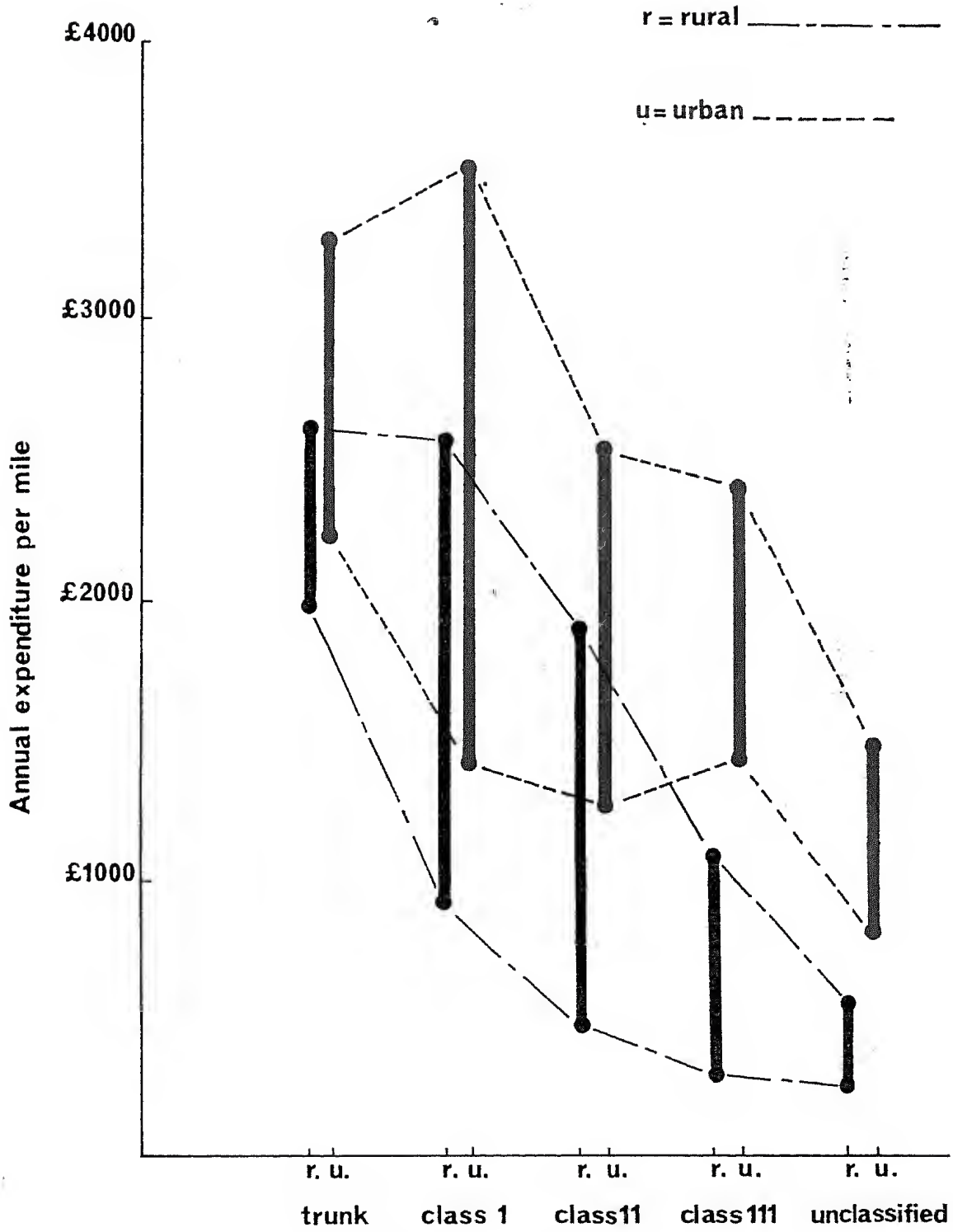


Fig. 4. Normal range of total annual expenditure on maintenance by class and type of road

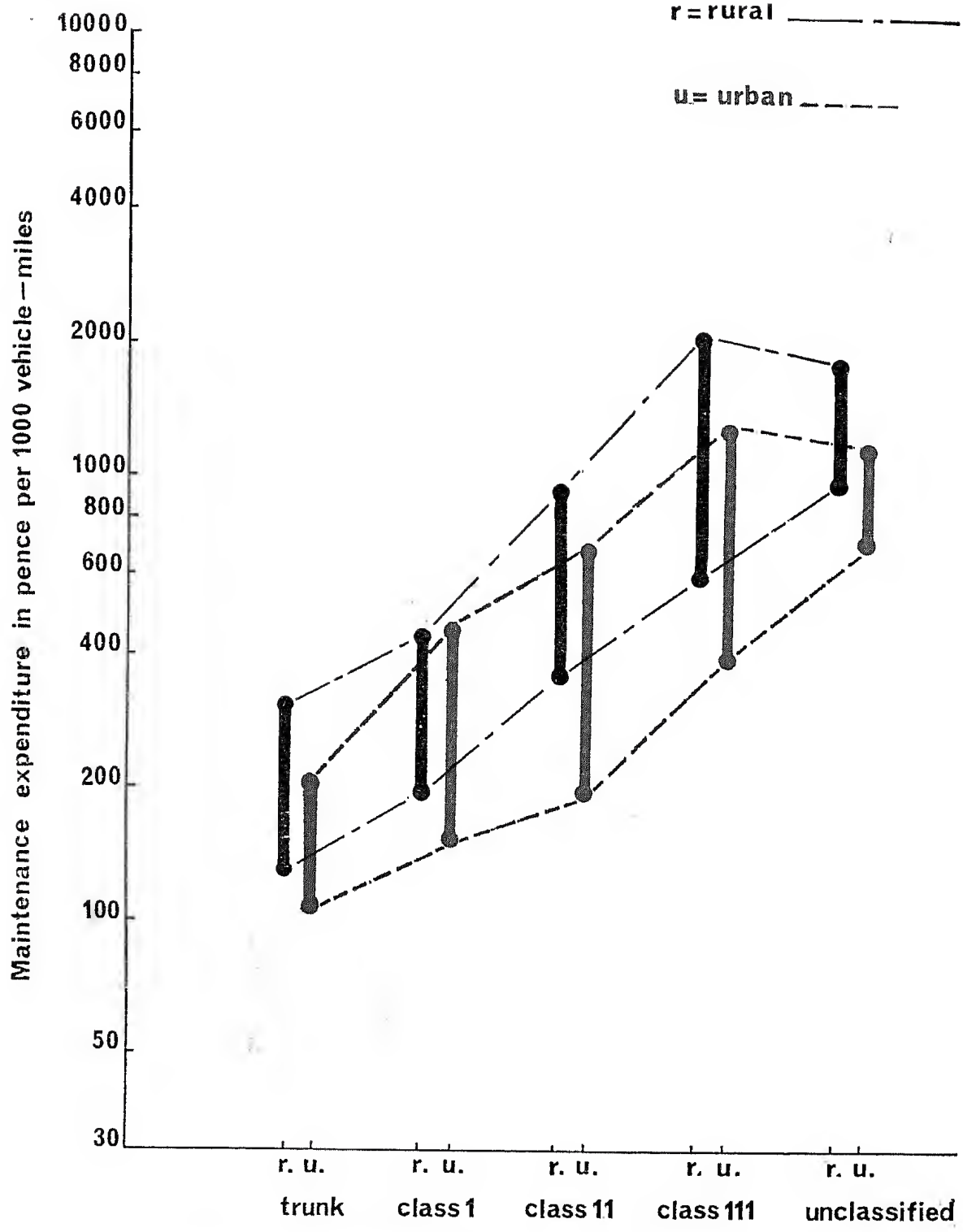


Fig. 5. Normal range of cost-usage for maintenance by class and type of road

Appendix 8: National Organisations Providing Training in Maintenance Attendance at at their Courses

Part A: The Organisations

CITY AND GUILDS OF LONDON INSTITUTE

1. This Institute, established in 1878, provides syllabi and examination papers for a number of industries. Besides offering courses for various skills in the building industry, it set up in 1962 a basic roadwork course, known as Roadwork 99, which is the only available basic training course for maintenance roadmen even though it is not specifically designed for maintenance. It covers a wide range of highway skills in order to provide a minimum standard of competence for the road worker or craft apprentice. There is first a theoretical section followed by two sets of practical work, one for roadmen and the other for those wishing to qualify as masons or paviors. The course has recently been reduced from three to two years and is generally run in local technical colleges on a day-release basis. The Institute now offers an additional, advanced, course intended to bridge the gap between Roadwork 99 and courses for foremen.

INSTITUTE OF WORKS AND HIGHWAYS SUPERINTENDENTS (IWHS)

2. The Institute is a voluntary body incorporated in 1939 which aims to provide a standard of competence for those in supervisory posts concerned with municipal services and the public works and civil engineering industry. The Institute aims to promote knowledge of management techniques as well as of technical and practical advances. Its examinations and syllabi have been approved by the Institution of Municipal Engineers which recommends that all suitable staff in municipal engineers' offices should have the appropriate IWHS qualification. In the past only those in local government and similar authorities were eligible for entry and membership but following negotiations between the Institute and the CITB eligibility was widened in January 1970 to those in the industry as a whole. The new structure came into operation in January 1970 and is the result of discussion with DES, City and Guilds of London Institute, IME, CITB and LGTB.
3. There are various grades of membership which have recently been redesigned to provide recognised qualifications from the working foreman to the Works Manager, who may control all the outside work of a maintenance organisation. Membership is through a combination of examina-

tions and practical supervisory experience. The examinations follow attendance at two- and three-year courses organised by IWHS for supervisors in civil engineering and constructions posts; these are usually held at technical colleges on a day-release basis. The syllabus covers organisation and administration and technical subjects including highway maintenance, lighting, mechanical transport and plant, public cleansing, sewerage and drainage.

NATIONAL EXAMINATION BOARD IN SUPERVISORY STUDIES

4. This Board, set up in 1964 by the City and Guilds of London Institute, provides long-term training for supervisors, suitable for men in any industry. The Board's courses are based on 240 hours of study on a day-release basis at technical colleges. The course can be completed in one year. The resulting qualification is accepted by some local authorities an as alternative to membership of the IWHS.

THE CONSTRUCTION INDUSTRY TRAINING BOARD (CITB)

5. This is one of the industrial training boards established under the Industrial Training Act, 1964, and its responsibility, which at first covered only building and civil engineering, now extends to roadwork. As mentioned in Chapter 7 of the main report, there is a temporary difficulty in extending the CITB's cover to local authority workers. The CITB is concerned particularly with the training of 'on-site' workers. Its Construction Industry Training Centre at Bircham Newton, Norfolk, established originally to train men in the use of heavy plant, is now also used as a focal point for the development of new courses.

6. The CITB has developed at the Bircham Newton training centre a wide variety of practical, supervisory and work study courses. The new supervisory courses at *basic* and *general* levels have been set up in accordance with the management development concept; this means that they aim to provide a minimum standard at an initial course and to follow this with modules of additional training with technical, trade or management bias. Instruction in *basic* supervision is designed for those with no previous supervisory experience who are being prepared for a post in which they will be supervising men of their own trade or background. *General* supervision courses will be for those already in supervisory posts who are to be given oversight of workers of different disciplines whose basic trade may be unfamiliar to the trainee. Both the basic and general level supervisory courses were offered for the first time in September 1969 at about 30 technical colleges. Though designed mainly for the building industry, these courses are considered suitable for those in highway work. Development work is now in hand for supervisory courses for other sections of the construction industry.

7. A Civil Engineering College for school leavers at Bircham Newton was opened in September 1969. It provides two-year full-time courses for

potential supervisors to give them wide experience in many construction skills and specialist knowledge of one particular skill which will enable them to find a job more easily on qualifying. It is envisaged that after some practical experience graduates from this college will be well placed to take on supervisory responsibilities.

THE LOCAL GOVERNMENT TRAINING BOARD (LGTB)

8. The LGTB started work in April 1968 with the specific role of promoting further training for local authority employees in order to increase productivity and efficiency. Its work would also help to distribute the cost of training more equitably among local authorities. The Board took over the role of the Local Government Examinations' Board of advising the National Joint Councils for manual workers and county roadmen on training matters. Although it is responsible for ensuring that provision of training is adequate at all levels, the LGTB operates through the industrial training boards on questions concerning the training of local authority manual workers. Its own work is mainly directed to the training of 'off-site' workers above the level of foremen.

9. In addition to approving existing courses, such as those of IWHS, for grant purposes, the LGTB have filled gaps in their provision by developing their own courses for existing supervisors. Ten provincial councils in England and Wales now offer between 4 and 6 of these short residential courses each year for supervisors of manual workers from all types of local authority and all departments. In the courses, based on a specimen programme laid down by the LGTB, there is first a week's elementary course in supervisory techniques, work study appreciation and human relations; this is followed after about 9 months of practical work by another more advanced one-week course in which the topics of the first course are discussed in greater depth and in the context of the men's experience in applying the techniques.

TRADE ASSOCIATIONS

10. Certain trade associations, including the Cement and Concrete Association and the Road Surface Dressing Association, each run one or two technical courses for foremen and supervisors. The RSDA's courses were in 1969 made available to county council staff and this arrangement is to continue.

ROAD RESEARCH LABORATORY

11. The Road Research Laboratory organise technical refresher courses for engineers in middle management. There are generally four courses each year which cover topics relevant to maintenance, which are now included with broader roadwork aspects.

Part B: Attendance at Courses

ROADWORK 99

1. A survey carried out in 1965 established that 121 out of a total 20,000 roadmen in counties only were taking the Roadwork 99 course. It has not been possible to discover exactly how many roadworkers in local government as a whole are eligible for the course, but the figure is probably over 30,000. At present only 300–500 sit the examination each year. Of the technical colleges offering Roadwork 99 courses only 14 can claim more than ten students and 12 of these are in the north of England or Scotland.

SUPERVISORY COURSES

IWHS courses

2. IWHS has 3,500 members but the number of foremen in construction work alone in all local authorities is approaching 20,000. About 450 candidates took the qualifying examination in 1969. On the supervisory courses attendance in the north is also greater than elsewhere. 60% of the candidates for the IWHS examinations come from north of Birmingham, and 90% of the total candidates are local authority employees.

3. Of the 9 county and 13 urban authorities visited by the RRL only 5 and 4 respectively have recently had staff on IWHS courses or courses of the National Examination Board in Supervisory Studies. For foremen IWHS qualifications were either required or preferred by all urban authorities of over 100,000 population which took part in RRL's standards study but by only half the urban authorities with a smaller population.

LGTB courses

4. The courses run for supervisors of manual workers by the provincial councils attract a large number of officers from highway departments, who seem to find them particularly helpful. A total of 1,370 supervisors from all departments took such courses in 1968/69, and about 1,510 in 1969/70.

GENERAL

5. 8 of the 22 authorities visited by the RRL have foremen in training, often as part of a regional training scheme, but only one of the three counties which require qualified supervisors has any currently in training. Of the 33 authorities visited by the consultants, only two counties have regular arrangements for training foremen, while little or no training of this kind is provided by the other authorities. Age of staff is an important factor in the amount of training provided at this level. Of the five urban authorities visited, where the staff's average age is below 45, four provide their foremen with training. Very few authorities require a formal qualification for working foremen or chargehands.

COURSES AT BIRCHAM NEWTON

6. The CITB plans that the Bircham Newton training centre should eventually have an annual through-put of 2,000 trainees; at present the maximum number of trainees at any one time is 400 but this should rise to almost 700 by 1971 when the local training centres should be bearing some of the load.

RRL REFRESHER COURSES

7. The RRL run technical refresher courses for engineers and supervising technicians which seem to be the only ones of their kind. We find that they are attended primarily by local authority employees and are very much in demand. However, maintenance operations form only part of these wider courses in highway construction. The courses, available to both contractors and highway authorities, provide about 150 places a year of which well over half have in recent years been taken by staff of local highway authorities.

MANAGEMENT TRAINING

8. The consultants found that over half of the 33 authorities they visited had sent no men of middle management level on any courses during 1968. The highest figure was from a county council and amounted to $3\frac{1}{2}$ days training per man year. The average rate of training amounted to only $\frac{3}{4}$ of a day per man each year.

Appendix 9: Summary of LGORU Investigation into the Value of Roads

The Definition of Road Value and its Interpretation

1. The Local Government Operational Research Unit (LGORU) defined the value of a road as the extra cost that would be incurred by the community if the road were not there.

Principles of Assessment of Road Value

2. The Unit considered the existing traffic patterns in a selected network of roads (the Newent area of Gloucestershire: see map) and predicted how the same set of road users would make their journeys if a particular road was not available. The extra cost was taken to be the increase in vehicle-operating costs (including a valuation of additional travelling time) incurred:—

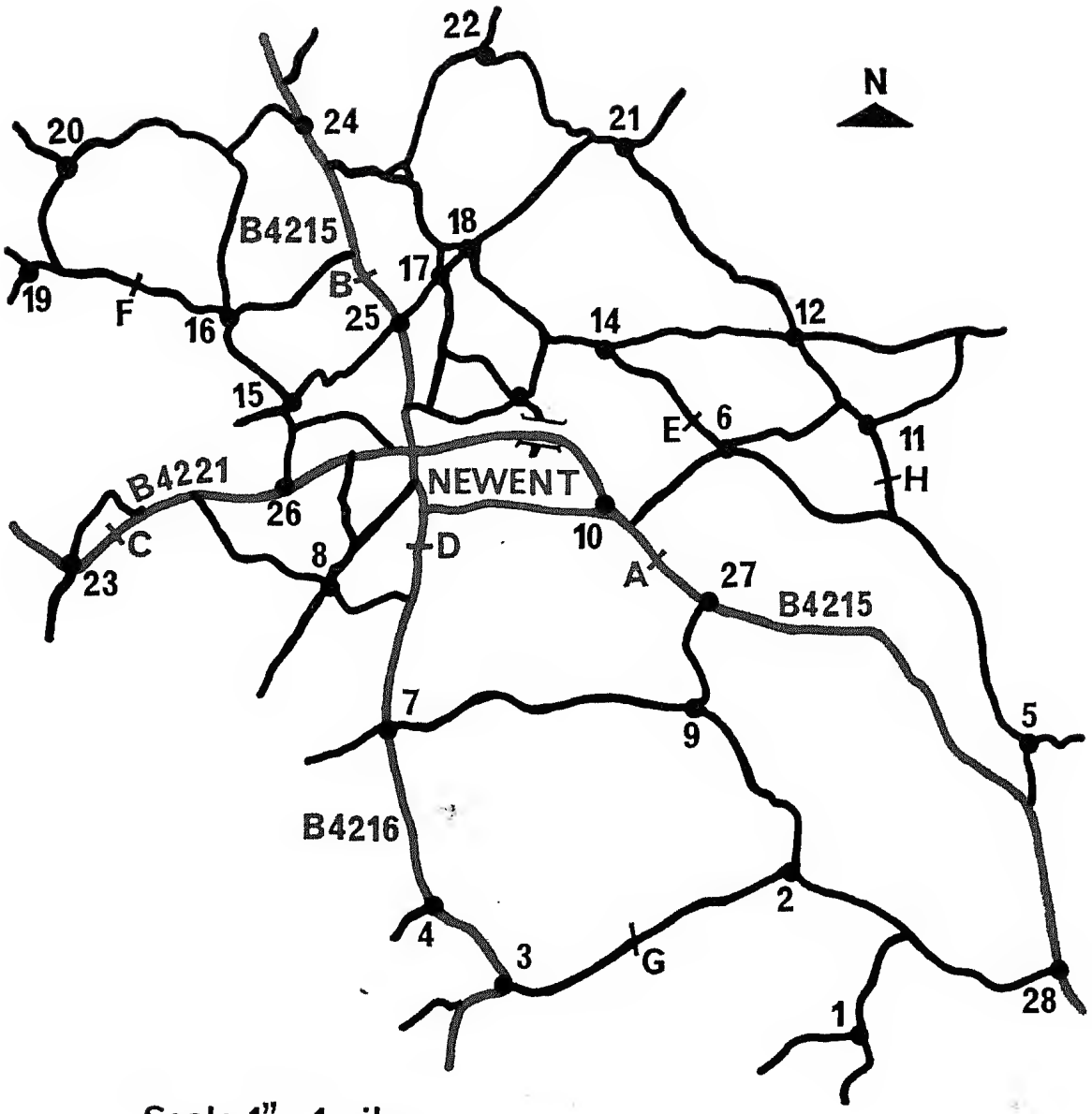
a. by drivers having to take an alternative route;
b. by other drivers already using those alternative routes whose journey times were increased by the additional traffic.

3. The Unit did not take into account the extra cost to the community of increased accidents due to the additional mileage because they could not obtain detailed information about accidents for the minor roads in the Newent area. Estimates from available figures suggest that accident costs would be increased by a maximum of ½d per vehicle-mile and that their inclusion would add no more than 5% to the values obtained.

4. One major problem in applying the definition was to decide how to deal with traffic using a road solely for access to adjoining property. Since the ultimate aim of this study was the allocation of funds for maintenance, it was felt that the concept of a road 'not being there' could be replaced by the concept of a road in a very poor state of repair. The LGORU therefore decided that people needing the road for access could still use it but that their speeds would be drastically reduced and their vehicle operating costs considerably increased.

Calculating Road Value

5. Having obtained comprehensive information on traffic movements by means of a number plate survey and flow information for each road-length, the LGORU also obtained information on the length and width of each link so that they could calculate the total operating cost for all the links of the network on the day of the survey.



Scale 1"= 1mile

The network of road links (a link is a stretch of road between consecutive junctions) selected for the study is shown by the numbers on the above map.

Fig. 6. The Newent Traffic Survey

6. Finally, in order to value a particular link they re-assigned its traffic to suitable alternative routes. In the process of valuing each link, traffic flows on other links were inevitably altered. This resulted in a new (in general, higher) total vehicle-operating cost for the network. This new cost minus the original cost provided the value of the link in question.

7. The Unit then tried to identify the most important factors affecting a road's value, eg traffic flow, link length and width and lengths of alternative routes, in order to devise a formula which could be used to estimate this value without the need for the detailed field study described above. The most successful formula explained 80% of the variation; it was based on traffic flow, link length, link width and population. Since traffic flow data are not normally available for minor roads, the Unit attempted to produce a useful formula without this factor but the best of these produced only half as good an explanation as formulae including flow.

Conclusions

8. The main conclusion is that traffic flow is the key to a road's value to the community; other factors have relatively little influence. It is not possible to base many other firm conclusions on this pilot study, carried out in one small area. We believe however that the approach could be used only in rural areas since the traffic re-assignment problem would otherwise be too complex, and that formulae of this kind could be used in relation only to minor roads because elsewhere traffic flow would be so important that valuation would not be affected at all by other factors.

Appendix 10: Savings from Reduced Maintenance on Minor Roads

Minimum Maintenance

1. We decided to try to assess broadly what resource savings were likely to be obtained by closing very minor roads or maintaining them at a level suitable only for vehicle access at 5 mph—*minimum maintenance*. Two counties, Gloucestershire and Lanarkshire, co-operated in an exercise to this end and we are most grateful for their help.

Gloucestershire

2. Gloucestershire had already provided the site for the LGORU road valuation study described in Appendix 9. For the minimum maintenance study we asked them to consider the possibility of closing or providing only minimum maintenance on the 10 roads given the lowest value by the LGORU and to assess the likely savings in such cases. Gloucestershire concluded that only 5 of the 10 road links could be either closed or given minimum maintenance treatment. Savings on the 10 roads would then be about one-third of the current level of expenditure.

3. All 10 roads considered by Gloucestershire are unclassified and their total mileage represents less than 1% of the county's unclassified roads. This was too small a sample to enable us to conclude that one-third of maintenance expenditure on a high proportion of the remaining unclassified roads would be saved by adoption of the minimum maintenance approach.

Lanarkshire

4. In order to estimate the likely savings from a minimum maintenance policy in Lanarkshire the County Surveyor first identified within one of their districts all little used culs-de-sac and any other rural roads for which there was an alternative of reasonable length. From these they identified lengths which might be considered suitable for minimum maintenance only. These amounted to about 20% of the total rural unclassified road mileage in the district. The exercise took no account of factors such as the existence of bridges on some of these roads. However, even on the assumption that 20% of the rural unclassified mileage in the whole county were to be maintained to the minimum standard defined above, the annual saving amounted to only 0·6% of the county's total maintenance budget.

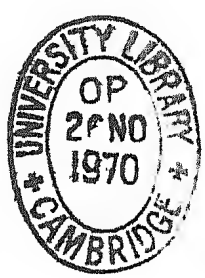
5. The County Surveyor was doubtful whether any valid conclusion for the country as a whole could be drawn from this exercise since it covered only a small sample of roads. He told us that an effort some years ago to delete a number of minor Lanarkshire roads from the list of highways maintained by the county met with some strong opposition which was relatively successful. He suggested therefore that if the likely savings from minimum maintenance are as small as the study indicates, the policy would not be worthwhile.

Oxfordshire: Reduction of Non-Principal Road Maintenance

6. In a report to the Oxfordshire County Council in 1967, the Highways Committee described the maintenance of non-principal roads as 'the greatest drain on the Council's resources in both money and manpower'. Having decided that planned improvements to non-principal roads would not now take place, the Committee suggested steps to reduce the maintenance they required.

7. They proposed the division of non-principal roads into two categories: two-lane roads and single lane roads with passing places. Class II and most Class III roads were expected to be placed in the first category, together with unclassified roads forming the main link between villages. Roads terminating in small communities or paralleling other routes would be placed in the second category, use of which would be limited to vehicles weighing under 3 tons. They also proposed that no new direction or warning signs be erected on non-principal roads and that grass cutting and sweeping should be done less frequently.

8. The policy set out above has been accepted by the Council. It is now being implemented and over 400 miles of road have been approved for inclusion in the second category. Oxfordshire estimated initial savings of 10% rising eventually to 25% of their non-principal road maintenance expenditure. This was £390 per mile for the year ending April 1968 and has fallen in two years' application of the policy to £320 per mile.



Appendix 11: Organisations and People who Submitted Evidence to the Committee

Central Government

Ministry of Defence (Navy)
Ministry of Public Building and Works
The Nature Conservancy

Local Government

City Engineer of Leicester
County Councils' Association
County Surveyor of Denbigh
County Surveyor of Oxfordshire
County Surveyors' Society
Highway Engineer of Leeds
National Joint Council for Local Authorities Services
Staffordshire County Council

Professional Institutions

Institution of Highway Engineers
Institution of Municipal Engineers

Training Organisations

Construction Industry Training Board
Gloucestershire County Council (South West Counties Training Scheme)
Institute of Works and Highways Superintendents
Local Government Training Board

Trade Associations and individual firms

Asphalt and Coated Macadam Association
British Granite and Whinstone Federation
British Road Tar Association
British Roads Federation
Burt, Boulton and Haywood Ltd
Cement and Concrete Association
Galliford and Sons Ltd
Road Surface Dressing Association

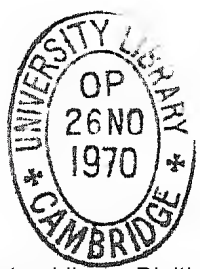
Individuals

Mr H. E. Beckett
Mr S. H. Crowle
Mr L. Gordon Davies
Mr J. Ford
Mr A. H. Kennard
Mr L. J. Last
Mr E. W. Potter
Captain V. A. Spilsted, RAMC
Professor E. W. Yemm (Bristol University)
Mr L. A. Young

Appendix 12

Key to Abbreviations

BS	British Standard
CITB	Construction Industry Training Board
DEP	Department of Employment and Productivity
DES	Department of Education and Science
DRE	Divisional Road Engineer (Ministry of Transport)
EP	Effective Performance
HNC	Higher National Certificate
IME	Institution of Municipal Engineers
IWHS	Institute of Works and Highways Superintendents
LAMSAC	Local Authorities Management Services and Computer Committee
LGORU	Local Government Operational Research Unit
LGTB	Local Government Training Board
NBPI	National Board for Prices and Incomes
NJC	National Joint Council for Local Authorites' Services (Manual Workers)
ONC	Ordinary National Certificate
PUSWA	Public Utilities Street Works Act 1950
RRL	Road Research Laboratory
SCRIM	Sideways Force Co-efficient Investigation Machine
SMV	Standard Minute Value



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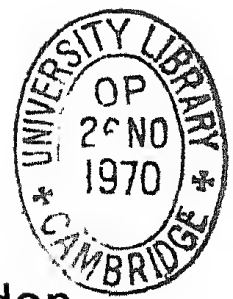
Report of the Committee on

Highway Maintenance

Report to the Minister of Transport
the Secretary of State for Scotland
the Secretary of State for Wales
the County Councils Association
the Association of Municipal Corporations
the Urban District Councils Association



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Foreword

1. We were appointed in October 1967 to consider and make recommendations on the planning, execution and financial control of highway maintenance work, with particular reference to:

a. the determination of units of output and the establishment of a suitable uniform costing system related thereto;
b. the establishment of economic standards of maintenance by type of road;
c. the measurement and improvement of productivity.

2. We have had 25 full Committee meetings and in addition the three sub-committees into which we divided to carry out our research met on 15, 14 and 12 occasions respectively. We have reached a wide measure of agreement and all accept the report as it stands.

3. In gathering evidence we have relied heavily on a large number of people, particularly in local authorities. Many have given generously of their own and their staff's time to help our enquiries for which we thank them. In particular the counties of Lincolnshire (Lindsey) and Lanarkshire helped us with maintenance ratings, and the Assistant County Treasurer of Essex, Mr N. K. Warden, and the Group Accountant, Mr A. G. Carruthers, joined with the RRL in preparing the discounting examples. We are also grateful to all who sent in written evidence. They are listed in Appendix 11. Not all the available information could be included in our report but we have included as much as we judged to be of general use in the Appendices in order that the report itself could be limited as far as possible to general principles.

4. We are much indebted to the Road Research Laboratory whose long-term plans for research into highway maintenance were adjusted to accommodate the needs of our studies. In addition to Mr Nicholas, our member from the Laboratory, we would mention our appreciation of the extensive work done for the Committee by his assistants, Lt Col P. J. F. Wingate, Dr R. H. H. Kirkham and Mr C. H. Peters. Their efforts have enabled us to put forward both a set of defined maintenance standards and a rating system to establish maintenance priorities.

5. Our work has been enriched by the interest and practical help of the Ministry's economic section. Other branches of the Ministry have readily responded when called upon. We would particularly record our thanks to the Secretariat of the Committee for their untiring and cheerful support at all stages and in all phases of our work. We have had three successive secretaries from the Ministry of Transport, Mr J. W. Baker, Mr J. A. Dole and Mrs A. S. Gittelson and one from local government, Mr C. Gordon, whose services were kindly made available by the City of Norwich. They have been ably assisted by their supporting staff, Miss D. A. Nichols, Mr C. R. Reichhold and Mr J. A. Spencer, sub-

sequently replaced by Mrs M. Marshall, each of whom acted as secretary to one of the smaller groups. We are also grateful to Commander C. H. Fothergill whose services as Project Manager were made available by the London Boroughs Management Services Unit and to Mr B. E. Cox, Assistant County Surveyor of Hertfordshire whose experience of highway maintenance both in this country and in North America was of great assistance in the standards study. We much regret the deaths during the period of our study of Mr Hartwell of the Ministry and Dr Kirkham of the RRL both of whom had been most helpful.